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STUDIES IN REPRODUCTION—THE ADIRONDACK HARDWOOD TYPE [1]

BY SAMUEL N. SPRING

Professor of Silviculture, Cornell University

Academic discussion of forest treatment and theorizing are giving place today to observational studies and scientific research. Much that is helpful in the practice of forestry is obtainable at once by studies of conditions following cuttings, particularly with reference to reproduction, adequately supported of course by data taken by the plot and the strip method. It would be especially desirable to study results following controlled cutting but if this opportunity is lacking the close observation of the effects of logging under its varying degrees of removal will afford much direct evidence.

Hawley [2] points out that in irregular, overmature, virgin forest the style of cutting is rather rigidly circumscribed by the condition of the timber, logging possibilities and other economic conditions; that these forests are in a transition stage between the unmanaged forest of the past and the managed forest of the future. After this stage he indicates that subsequent cuttings for reproduction will become both possible and necessary. This is essentially the situation in the Adirondack hardwood type.

Our judgment of the effect of the present character of cuttings must be based on the adequateness of regeneration and the conditions favor-

[1] Presented before the Society of American Foresters at Toronto, December 27, 1921.

[2] The Practice of Silviculture (pages 15 and 16), John Wiley & Sons, 1921.

NOTE.—Acknowledgment is here made of valuable assistance of Professor A. B. Recknagel, by graduate students W. W. Simonds and Felix Franco, and for assistance of 1920 and 1921 Cornell students in field work.

able or unfavorable to the development of young growth as well as development of the remnant forest, left after logging. If regeneration is ample and if conditions for development are favorable we cannot characterize heavy cuttings as ruthless destruction and term lands so cut as devasted no matter if for the time being they are unsightly.

Reproduction following logging in the northern hardwood type cannot altogether be termed haphazard, not from nature's standpoint. Not infrequently reproduction is already determined, as evident in abundance of advance growth. If logging immediately follows a seed year the young growth present may be supplemented by many seedlings.

The investigations reported in this preliminary paper were made chiefly on lands of the Oval Wood Dish Corporation on the northwest slope of Mt. Morris in the western Adirondacks near Tupper Lake, N. Y.

The first logging was for softwood saw-timber in 1874, then about 1892, and again the forest was cut over for hemlock and pulpwood about 1905. In 1920-21 the tract was being logged for pulpwood and hardwoods.

FOREST RENEWAL IN SMALL OPENINGS AND ON SMALL CLEARED AREAS

Softwood operations carried out approximately 25 to 30 years ago resulted generally in small openings in the forest. In the hardwood type of slopes and benches old stumps indicate that softwoods were removed singly or two or three in a group. If a single spruce, for example, had its crown up above the hardwoods or below them practically no opening was made by its removal. If its crown was among the hardwood crowns the latter filled up the gap in a relatively short time or at best a small opening only remained. This statement on relative position of crowns is based on the observation of spruce in hardwood type on adjacent land that has no evidence of logging operations. In the case of groups of several trees a larger opening resulted from their removal, but the size of these openings judged both by area of young growth and by old stumps of the first and second softwood operations was a fraction of an acre, often a very small fraction.

Selected plots were taken on the hardwood type to determine the regeneration effected by these cuttings. The plots were laid out in rectangular form to include old stumps of softwoods. Typical examples are shown in Table 1.

Seedlings under one foot in height were usually plentiful for hard maple and scanty or absent for other species.

TABLE 1.—*Number of Seedlings and Saplings Following Selective Softwood Cuttings Made About 15 Years and 25 Years Ago.*

(North slope—Hardwood type—Plots 33 by 33 feet in size)

	Hard maple	Yellow birch	Beech	Miscellaneous	Spruce
Seedlings[1]	100	12	4	8	0
Saplings[2]	5	6	2	3	0
Seedlings	33	2	1	2	0
Saplings	4	2	..	2	0
Seedlings	16	7	1	4	0
Saplings	0	1	5	..	..
Seedlings	164	0	40	36	0
Saplings	1	0	5	1	2
Seedlings	48	0	0	0	0
Saplings	4	3	0	7	0
Seedlings	44	0	0	2	0
Saplings	3	0	1	18	0
Seedlings	42	1	1	0	0
Saplings	0	0	12	0	0
Seedlings	0	13	27	0	3
Saplings	8	2	7	0	2
Total	472	49	196	83	7
Total per acre.	2,360	245	530	415	35
Grand total					3,585

These results indicate, so far as numbers were concerned, that the openings were in general adequately stocked with hardwood seedlings and saplings. Spruces of the seedling class were lacking in reproduction on these plots and where saplings were present these had had their start before the softwoods were cut.

Observations were made on an area that was clean cut for camp fuelwood. The data were taken on typical hardwood land of the lower slope. A dense stand of straight, thrifty hardwoods has come in since clearing 25 to 30 years ago. The average number of trees per acre, based on .4 acre, at 26 years of age, is 1,000, of which 40 per cent are hard maple, 35 per cent yellow birch, 20 per cent beech, and 5 per cent

[1] From 1-foot height to .5-inch diameter at 4.5 feet from ground.

[2] From .6 inch to 4.5 inches (inc.) diameter at 4.5 feet from ground.

miscellaneous. This area has not been burned over since clearing. It was near the former site of a large hauling camp and as nearly as can be judged covered several acres.

Another similar area of second growth near the Cornell Forestry Camp on this same tract is said to have been burned over by a light surface fire. It has a fairly dense stand but differs somewhat in composition and contained some few trees left in cutting. Based on a half-acre sample plot the percentages by species are hard maple 36, yellow birch 28, beech 10, poplar 6, and miscellaneous 20. The average number of trees per acre is 1,626. The greater number of trees would seem to indicate a better stand than the one previously mentioned. It is not, however, as well stocked with valuable species, since 17 per cent of the total number of trees are striped maple existing chiefly as an understory. Form and condition of the trees are also less good. Any fire, even a light surface fire, is detrimental.

In all the cases cited seedlings and saplings wherever present found suitable conditions for growth for a time at least after the trees above were removed and the places not possessing advance reproduction were filled in with trees from seed of the year just previous to logging or from seed shed after logging by trees adjoining the openings.

FOREST RENEWAL ON HEAVILY LOGGED LANDS AND ON LARGE CLEARED AREAS

The immediate appearance of the hardwood type that has just been logged both for pulpwood and merchantable hardwoods as the tract under consideration was in 1920-21 gives the impression of devastation to the casual observer. The crown cover of the forest is broken or wholly absent in some places, a large amount of slash lies in huge piles. For the time being the area is unsightly when viewed at close range. From a distant view the slopes appear to be timbered because many trees are left after the logging of merchantable ones.

The average stand before and after cutting in typical hardwood land on this tract is given in Table 2 and in a graph prepared from measurements on a 2-acre plot measured in 1920 and again in 1921 after the logging. This graph (not shown here) shows certain distinct facts. First, practically all trees over 12 inches diameter breast high have been cut; second, there has been a marked reduction in the number of trees below 12 inches through destruction in felling operations. Third, there

are still left a good many saplings below 4 inches and a number of trees from 4 inches to 12 inches in diameter. Fourth, occasional larger trees remain that are non-merchantable.

Two hundred and eight trees is not by itself adequate basis for a new crop, the crown cover has, however, been very largely removed and light admitted to the ground. In order to judge future possibilities it is necessary further to find out what reproduction is now present. This was done by taking plots at arbitrary equal intervals across the two acres and making counts of seedlings below the 1 inch class that is recorded in the graph. These plots thus located were respectively on a skidding trail, in or on the edge of brush piles and in openings between brush piles so that all conditions were thus touched. The data are as follows:

TABLE 2.—*Seedlings on an Area Logged for Merchantable Pulpwood and Hardwoods.*

(Based on 8 plots of 1 square rod each)

Area	Beech	Birch (yellow)	Maple (hard)	Maple (soft)	Raspberry	Witch-hobble
On 8 square rods....	205	674	255	50	13	48
Per acre............	4,100	13,480	5,100	1,000	260	960

Total per acre..22,680 seedlings

It is interesting to note that raspberry comes in the first spring following logging.

In order to ascertain conditions on a more extensive area of cut-over hardwood land the stand after logging was determined by calipering and recording by diameter classes trees on strips 66 feet wide and 10 chains apart running across the tract from an established base line.

Table 3, based on 9.5 acres of strips, gives the average number of trees per acre. In this case no trees below 4 inches diameter were calipered, hence the number appears as less than on the 2-acre sample plot.

All of the logging operations previously mentioned left, as has been seen, a considerable number of trees per acre many of which will form the basis of another cut in from 20 to 30 years. This stand will be supplemented by the development of seedlings and saplings already present and possibly by further natural seeding. Two things were especially noticeable on this tract, (1) that hard maple seedlings from 1 year to several years of age were usually plentiful, and (2) that

where soil and leaf mold had been stirred up together thousands of one year old birch seedlings were found which had come up following the heavy seed crop of birch in 1920.

TABLE 3.—*Average Number of Trees (4 Inches and Above) Per Acre on Hardwood Land Logged for Merchantable Pulpwood and Hardwoods in 1920-21.*

(Based on 9.5 Acres)

D. B. H., inches	Hard maple	Yellow birch	Beech	Balsam	Spruce	Hemlock	Miscellaneous	Total
4	2.4	2.1	4.8	.1	1.8	....	1.4	12.7
5	2.3	1.6	1.9	....	2.0	.3	.5	8.6
6	1.9	1.6	2.4	....	1.5	.1	.1	7.8
7	2.1	.8	.5	....	.6	.4	....	4.5
8	1.5	.5	1.7	....	1.0	.1	....	4.7
9	1.7	.5	1.1	....	.4	....	....	3.7
10	1.9	.1	1.4	....	.1	....	....	3.5
11	1.9	.1	.8	....	.4	....	....	3.4
12	1.5	....	1.5	....	.1	....	....	3.0
13	1.1	.1	.6	....	....	....	....	1.9
14	.9	.1	.3	....	....	.1	....	1.5
15	.4	.1	.6	....	....	.1	....	1.3
16	.7	.2	.5	....	....	....	....	1.5
17	.1	.1	.1	....	....	....	....	.3
18	.3	.1	.3	....	....	....	....	.7
19	.1	.1	.1	....	....	....	....	.4
20	.1	.1	.1	....	....	....	....	.3
21	....	.3	.1	....	....	....	....	.4
22	.1	.1	....	....	....	....	....	.1
23	.1	....	....	....	....	....	....	....
24	....	....	....	....	....	....	....	....
25	....	.1	....	....	....	....	....	.1
26	.1	....	....	....	....	....	....	.1
27	....	.1	....	....	....	....	....	.1
28	....	....	....	....	....	....	....	....
36	....	.1	....	....	....	....	....	.1
No. of trees..	21.4	9.3	19.2	.1	7.9	1.3	2.1	61.3
Per cent.....	34.6	15.1	31.2	.1	12.8	2.6	3.4	100.0

On the cutting preserve near Lake Ozonia in Franklin County plots [3] were laid out in the hardwood type in a study of the nature of cover, number of seedlings, and their development. The cutting in general took trees to an intended limit of 12 inches d.b.h., but sometimes took trees smaller than this. Tables 4 and 5, following, indicate adequate regeneration and fair to good development under varying conditions.

[3] Acknowledgment is made of assistance of graduate student A. A. Kraus in 1917 in gathering these data.

TABLE 4.—*The Character and Amount of Young Growth on Hardwood Land Cut Over Six Years Previously.*

Nature of cover	Amount of seedlings per acre	Height	Height of cover
		Inches	*Inches*
Under medium raspberry cover.	Hard maple... 4,800 Birch .... 1,600 Misc. 3,000	12 to 18	40
Under the shade of trees......	Hard maple...19,000 Beech .... 5,000 Birch 25,000	12 to 22	....
In the slash..................	Birch ....14,000 Soft maple... 5,000	4 to 32 (10-in. ave.)	....
In the open...................	Hard maple...77,000 Beech 44,000	20 to 40	....

For purposes of comparison with these lands on which a broken stand remained a completely cleared tract was sought.

Under Dr. Fernow's plan of clear cutting followed by planting of conifers on this type in the Adirondacks it was expected to develop a coniferous forest with some mixture of hardwoods from seedlings already present from natural seeding. The forest was cut clean excepting on certain reserved strips and ridges and then planted.

From a line parallel to and near the old Wawbeek Nursery strips were run out to ascertain the composition of the new forest that naturally followed a complete clearing accompanied by the burning of the logging slash in piles. Here planting had not been done at the time that operations were discontinued. The forest on this area was cut in 1902-3. It has grown up with fire-cherry accompanied and followed by hard maple, birch, beech, and miscellaneous species. The total average number of trees per acre is 1,089, based on 1.9 acres of strips run. The summary of results is as follows: Yellow birch, 74.27; spruce, 4.20; hard maple, 392.09; beech, 72.6; hemlock, 1.58; balsam, 1.58; soft maple, 3.68; cherry, 473.68; aspen, 31.58; miscellaneous, 34.20.

The cherry will shortly be dominated and suppressed by the other species. It may be considered a fairly well stocked stand. This area, then, which was left wholly bare without intention, shows that even under complete clearing the forest returns true to its type where fire is kept out.

TABLE 5.—*The Amount and Character of Reproduction on an Area of the Hardwood Type Cut Over Three Years Previously.*

Kind of cover	Seedlings reduced to an acreage basis		Height of reproduction	Average height of cover
			Inches	*Inches*
Shaded, under the cover of larger remaining trees. There is no other competing vegetation on the ground...	Hard maple	90,000	18 to 24	....
	Beech (sprouts)	1,000	14	....
Under fern cover	Hard maple	58,000	8 to 26	24
	Beech (sprouts and seedlings)	5,000		
	Birch	1,000		
Under slash	Hard maple	14,000	8 to 16	....
	Soft maple	1,000	12	....
Under grass cover	Hard maple	12,000	7 to 12	18
	Willow	2,000		
	Popple	1,000		
On moss cover	Popple	15,000	The seedlings varied in height from 12 to 20 inches.	....
	Willow	4,000		....
	Birch	11,000		....
	Soft maple	1,000		....
	Hard maple	1,000		....
Under light raspberry cover (defined as density of five to six raspberry plants per square foot)	Hard maple	15,000	Seedlings about 12 to 18 inches high.	36
	Beech	4,000		
	Birch	4,000		
	Popple	1,000		
Under heavy raspberry cover (defined as density of ten to twelve plants per square foot)	Hard maple	10,000	12 to 18	36

Baker and McCarthy [4] have given the number of trees per acre on the hardwood type on tract cut 11 years previously for hardwood and softwoods, near Wanakena in southeast St. Lawrence County. The total average number of trees by species from 1 inch to 12 inches inclusive (diameter breast high) is interesting as indicating the adequateness of stand likewise in this case and by way of comparison with the stand at Wawbeek: Yellow birch, 1752.24; spruce, 61.36; hard maple, 112.31; beech, 134.06; hemlock, 6.32; balsam, 24.33; soft maple, 133; fire cherry, 403.42; black cherry, 22.84; aspen, 2.37; total, 2,652.25.

Some preliminary conclusions concerning reproduction on the hardwood type as studied in the western Adirondacks are as follows:

(1) In respect to extent of area the forest has come back abundantly in small openings and in small cleared areas ranging from a fraction of an acre to several acres. On land logged for merchantable pulpwood and hardwoods in 1920-21 an adequate stand of trees is assured from saplings and seedlings found on the area at the end of one year with the further possibility of additional seeding by trees left in logging. Complete clearing on an extensive area at Wawbeek in 1902-3, the slash being burned in piles, a fairly well stocked stand of useful species has come back.

(2) Seedlings and saplings are found to be already present underneath in many parts of mature and over mature stands previously logged for softwoods.

(3) Areas bared by logging are naturally reforested when seed from a seed crop of the year just preceding the logging has been shed on the area.

(4) Where non-merchantable thrifty seed-bearing trees remain uncut these add seed subsequently to the exposed areas but seedbed conditions may be unfavorable.

(5) Reproduction may be temporarily overtopped by ground cover and underbrush, giving the outward appearance of failure of regeneration.

(6) There is considerable variation in the proportion of the different species in reproduction areas, depending on site and other factors.

There is need of a study of the remnant stand in its relationship

[4] Fundamental silvicultural measures necessary to insure forest land remaining reasonably productive after logging. Jour. of Forestry, Vol. XVIII, pp. 13-22.

to the development of the young growth on these logged areas. It is the belief of the writer that within 20 years trees left now in logging will on accessible lands be merchantable. Not all will live but there is a considerable proportion that are likely to live and grow vigorously. Silvicultural treatment will demand improvement cuttings to liberate young even-aged stands underneath or they may otherwise be subjected to oppression.

A practical question arises as to whether control of present cuttings can improve conditions for future production. In a measure as indicated at the beginning, the style of present cutting is circumscribed, nevertheless, I believe that a forester could designate groups for protection in logging, make studies of younger timber to determine whether certain size classes are profitable to log now or may make a more profitable return by reserving them for a future cut and designate these on areas being logged. Above all a forester can be useful to lumber companies by organizing properties for management and helping in the important problems of closer utilization that will make possible important silvicultural measures.

APPLICATION OF YIELD TABLES IN THE MEASUREMENT OF GROWTH ON LARGE AREAS

By H. H. Chapman

1. The elements causing yields to vary are of two classes, primary and secondary.

2. Primary elements are area and age. Yields are therefore primarily expressed as yields per acre for given ages.

3. The secondary elements are site, form (age classes in stand, as even-aged or many-aged), treatment of stand (natural growth or cultivated), species in mixture (pure or mixed stands), and density of stocking.

4. Sites form an unbroken series but are standardized and averaged in usually not over three site classes.

5. Form is considered the most difficult to standardize, that is, the many-aged form. Yield tables have usually been confined to even-aged stands.

6. Since insufficient material exists from which to construct yield tables from treated or thinned stands, yields of such stands are judged from those of index stands grown under natural conditions by assuming these latter tables as a base or minimum yield for the fully stocked artificially grown stands.

7. The difficulties of constructing yield tables for mixed stands are lately conceded to be overdrawn—provided the stands are even-aged. Mixed stands of this character offer no serious bar to yield tables.

8. The factor of density is the most urgent problem, since no two stands are alike in this respect no matter how carefully selected. The method known as the empirical yield table, or direct average of variable densities is worthless, being comparable to a volume table from which deductions have been made for cull. The construction of the index yield table must be the basis of handling this problem.

9. Prediction of future yield is the purpose of any yield table, and the method is by comparing the stand whose future growth is sought, with the yield table.

10. The term "index" or "normal" should not convey the meaning of a theoretical maximum yield but of an average yield on a given site

quality for a stand *whose area is fully occupied,* with a practically complete crown or canopy. Attainable yields, not perfect yields, should be the standard of the index table.

11. One, and the most useful, function of an index yield table is to correlate yield with age, that is, to measure the effect of age upon volume, independent of that site or other factors, and to create a scale of proportional values for this relation, expressed by the curve of yield based on age.

12. With this relation worked out the *application* of the yield table to any stand is made possible by determining the *age* and *volume* of the stand, and the percentage relation between this stand and the yield table at this age.

13. The most direct comparison is that of cubic volume (modified, in some tables as volume in units of product such as board feet). With the index yield as 100 per cent the volume is expressed in terms of the per cent of this yield. Prediction of yield is made by taking the same per cent of the future yields from the table.

This theory applies best to stands with full crown cover but which do not coincide in yield with the average expressed by the table. It may also be applied but less accurately to stands deficient in density.

14. Basal area may be substituted for cubic volume, to be compared with basal area in the table to determine this percentage relation. I doubt if this has any superiority over 13.

15. Number of trees per acre, an immense variable in nature, is also a source of great variation in yield except when controlled by thinnings frequently executed. Overstocking tends to diminish natural yields. Understocking tends to correct itself with age if distribution is sufficiently regular to permit the stand to finally utilize all the area through crown spread. Index yield tables aid by indicating the normal relative numbers of trees at different ages.

16. As Carter has pointed out, in case of understocking it may be necessary to predict a yield as more nearly approaching normal than would be indicated by the straight percentage reduction method of prediction based on present comparative volumes only.

17. The problem of determining yields of larger areas works from the simple to the complex. When stands in the field are even-aged, of a single age class and can be mapped, the measurement of their volume

will determine their past mean annual growth while their comparison with yield tables will predict their future development.

18. No growth data of any real value for long term forestry can be obtained on any other basis than area, age, and volume in the present condition of our forest areas. Growth per cent is a poor substitute and most inaccurately applied and conducive to gross errors, while current growth based on diameters instead of on ages is comparable with knowing the yields of an even-aged stand for 10 years past but not knowing how old the stand is. It is good only as far as it goes.

19. Site classification is of first importance, and is best based upon the height of dominant trees of key species at different ages. Standards of tree height growth should be worked out for New England, by types, to which all data on yield and yield tables should be coordinated, so as to enable the forester to coordinate these site classes in the field with yield tables. This is the most promising present field of research in mensuration.

20. There are many complications in the problem of separating age classes in forests of the many-aged form, but this condition is not frequently met in New England. Unless the effort is abandoned at the start in favor of either the growth per cent experiment or the makeshift of current growth based on diameters, the solution will depend on the exact nature of the problem in each type of forest, but it can usually be solved in some fashion on the basis of the age of the different age classes *and their approximate area.*

21. The first effect of mixed age classes is the impossibility of separating the area of each age class *by mapping*. Knowing the whole area, and the separate volume in each age class, the areas in each class can be found on the basis of distributing the average density of the entire stand equally over each age class. The small error in this assumption is negligible compared with not knowing anything about the area in any of the age components of the forest.

22. Yield tables of index form based on age should be used as the basis, and are just as valuable in application to these many-aged forests, as if the forests could be divided directly on basis of age classes instead of by use of diameters.

A yield table based on age can be made even for many-aged stands by careful selection of groups or even by measuring crown space or

growing space to determine the number of trees per acre, the age in this case being that of the trees of the diameter measured.

23. Since this yield table correlates volume with age, the correlation is possible only for the age classes which have attained a measurable volume, or the "merchantable timber." The *net* area occupied by these merchantable age classes is required.

24. But in many-aged stands the immature age classes are mixed among the merchantable timber, while in even-aged stands these age classes are separated by area. As a preliminary step, in applying any method of determining the areas occupied by different age classes of mature timber, this separation of immature age classes must be made, and made on an area basis rather than by numbers or counts which owing to the mortality per cent to be expected are practically worthless. Even a rough guess at this area to be credited to immature age classes is valuable, and corrects and improves the calculations made for the older areas and yields, by correcting and approximating for the true density of stocking of these older age classes. This estimate can be expressed on strips, by a percentage area figure and later reduced to acres.

25. With the net area so obtained, as the basis, divide the known volume in each age class by the index yield per acre, thus eliminating the effect of age as a variable, and determining the area required for this age class for 100 per cent or index stocking. The sum of these areas when compared with the total net area (see 24) gives the relative density of the whole forest, and the per cent of this total area, for each age class, gives the assumed area of the age class in the forest based on this density.

26. When it is not possible to directly determine age, the matter is more serious, since diameter is the only possible substitution. Age is obtained by correlating it with diameter through growth studies on trees and serves only as an average or rough indication of age, needing careful handling.

27. Substitution of diameter for age, to determine ages and separate age classes in many-aged forests is the only available method. It is full of pitfalls but is better than no knowledge, and for long time growth predictions and yields per acre or mean annual growth, can be made more accurate than the study of current growth which neglects age

altogether, if a little attention is paid, first, to the laws of diameter growth, second, to the object, which is to secure average age, and third, to the effect of suppression on age.

28. The so-called economic age of trees is the age required by them to produce crops if grown in even-aged stands not suppressed. Therefore, to get the average age of trees in many-aged stands requires the study of growth in patches of forest not under suppression, to determine the average ages of trees thus grown up to certain sizes. This applies especially to spruce for instance. Suppressed trees are not occupying economic growing space and the yields on an acre in a given time are not affected by this period of suppression, which must be reduced to normal.

29. With these precautions, studies of growth in diameter correlated with d. b. h. furnish curves of growth giving the age of trees of different diameters, and the average ages of trees embraced within different diameter groups can be found by obtaining the volume of the average tree, its average height, and from a volume table, its diameter.

30. With the age of diameter group thus found, the volume is also available from the estimate if a stand table obtained from a tally of diameters is constructed. The volume in each age class can readily be obtained for the entire merchantable stand. Then from the yield table, by the method described in point 25, the density of the forest is found, and the area occupied by each age class. Prediction of yield of each age class can then be made either based on a reduced yield table corresponding to the forest density, or this can be corrected for the effect of numbers of trees in the stand as under points 15 and 16.

31. This method of separating age classes requires that the basis, growth in diameter, be carefully correlated directly on the diameters of the trees, and not on their ages, that is, that the age of trees of given diameters be determined and averaged, so as to include the range of ages for a given diameter. If based on age, the average will include a range of diameters instead. This is apt to prolong the age of the larger trees and upper diameter classes beyond their true age, as these classes grow faster throughout life usually than the average mature diameter classes.

32. Or, if age is the basis of the average, age must be the basis of division of the trees into age classes instead of diameter. But one

method has been tested, and this accomplishes the division into but two groups which, in French forest regulation, is considered sufficient for many-aged forests containing no overmature or decadent timber. The method is to select from the yield table two ages corresponding with the groups to be made.

From the growth curve, the diameter of a tree of this age is found for each group, and from the average height, and volume table, the average volume. A stand table gives the total number of trees, and the total volume.

With the above data determined, there can be but one solution—the number of trees of each average diameter and volume can be found whose sum of volumes gives the total estimate—this gives the volume in each of the two age classes. A thorough check of this method has failed to show any inconsistencies in reasoning, and its application is quite simple. The algebraic solution is as follows:

$a =$ average volume of smaller or younger trees.
$b =$ volume of larger or older trees.
$c =$ total number of trees.
$d =$ total volume.
$x =$ number of younger trees.
$y =$ number of older trees.

Then $ax + by = d$

$$a(x + y) = ac$$

from which

$$(b - a)\,y = d - ac$$

$$y = \frac{d - ac}{b - a}$$

$$x = c - y$$

33. The two outstanding requirements of growth studies are therefore the separation and standardization of site factors correlated with height and yield tables, and the preparation of these yield tables on a normal or index basis. All other problems can be solved when these are attained.

The question now arises, as to the application of these methods of using yield tables, to obtain average growth data over large areas.

Note on the Measurement of Growth for Large Regions

By R. T. Fisher.

Fundamental to the determination of growth or volume increment over large areas is a forest classification based on percentage areas.

The regional classification has presumably been settled by the committee appointed for the purpose. In that connection, however, it is worth emphasizing that for purposes of timber assessment like the present the occupational or economic history of the land has often produced more definite uniformities of form, type, and condition than the fundamental factors of typography, climate, and soil. It is possible, for example, to consider a very large part of Central New England as containing even aged second growth forests of certain transition types with definite age limits, resulting from the treatment of the land. Probably a similar grouping could be made of the culled mixed forests of Northern New England. The first step, then, is to block up New England by regional units, based upon some such criteria as indicated above.

Within each regional block means must be devised for ascertaining the following facts:

1. The percentage of total area forested.

2. Within the forested area the percentage areas of each of the fewest possible number of types that must be reckoned with. This problem will doubtless be simplified by the establishment of the fact that, for a given age and site, yield is constant, regardless of species.

3. For each type:

(*a*) The percentage areas of major age groups taken, say, by twenty-year periods.

(*b*) The percentage areas of a minimum number of density classes. Very high limits would suffice, since it has been shown that final volume has comparatively little relation to number of trees per acre, and insufficient stocking tends to correct itself with age.

4. The percentage areas and the broadest possible site classes determined for this purpose on a topography basis. Probably for many regions it would be safe to call everything quality 2, and avoid this classification altogether. Certainly the determination by normal height growth is too complex for the purpose.

In any large scale problem of timber measurement it is the control of the factors of area that is most essential to a reliable result. In this case the data enumerated above make up the necessary control. It is possible that the broadest of the factors, such as the proportion of forest to open land and the type classification, could be secured by airplane photography, especially in settled country where the scale could

be checked by reference to features already mapped, such as roads and streams. The most obvious and practical method, however, is a set of parallel compass and pace traverses. Once the forest classification for the regional unit is settled upon, these could be made by an experienced man with fair rapidity, particularly where U. S. G. S. Map Sheets are available for checks. These traverses should be run across the main drainage of the country, since the belts of settlement and tillage would thus be cut at right angles and given their proportionate representation in total area. By such a method no actual determination of acreage, except that of the sum total of all the townships in the regional unit, would be necessary. Compiled from the traverses, the percentage areas of the several forest classes could easily be worked out and a sound basis secured for the application of index yield tables to the computation of growth.

THE RATE OF INTEREST AS A FACTOR IN THE COST OF GROWING TIMBER

By C. H. Guise

Department of Forestry, Cornell University

Everyone who advocates the establishment of forest plantations is confronted, at one time or another, with problems relating to the costs involved and the returns to be secured. Problems of this character demand that we take into account four factors, first the initial and annual costs, second the yields in timber to be expected, third the stumpage values of the product when mature, and fourth a rate of compound interest with which all charges can be carried from the time at which they are incurred until the trees are ready to be cut.

We know within reasonably close limits what it costs to start forest plantations and can also tell with fair accuracy the annual costs involved. the yields in volume and the future stumpage values are not so definitely known and we frankly admit that, at the present time, we can do little more than give intelligent estimates of these. Our existing yield data are all too scanty, but if those which we have are carefully used, we can give a good estimate of the volumes of wood that can be grown. The common practice is to use average stumpage values that exist at the present time. There is very little likelihood of their going lower, and all indications point to values that in future years will be higher. Although more exact information on the above factors would be greatly welcomed, we can, for many of our prominent species, use much data as we have and not be far out of the way. And as time goes on it is reasonable to expect that we will be furnished with much additional data on costs, yields and stumpage values.

The fourth factor, the rate of interest, is one that has come in for but little comment in the past. Yet the rate chosen is of great importance and to many is a standard that an investment in timber growing must reach if it is to be classed as worth while. The principal point in this paper is not to disagree with this opinion, but to offer a few comments as to the rate in interest to be used and invite discussion on the rate which foresters can agree upon as being fair and satisfactory from every standpoint. It is needless to go into a discussion

here of the problem of simple versus compound interest. Compound interest is universally used in calculating costs in growing timber and associated with it we usually find the rate of 6 per cent. It is highly probable that this 6 per cent rate is chosen because it is the rate that is found in most of our business transactions. But in most forms of business enterprise, simple interest is used. Outside of savings banks, insurance companies, saving and loan associations, and possibly a few other organizations, practically all of our business is carried on on an annual basis. No argument is to be advanced here for using simple interest with financial calculations in growing timber. Compound interest is always used where returns are deferred for a period of years, and timber growing should be no exception.

Although a rate of 6 per cent simple interest is universally accepted, is it fair to use a rate of 6 per cent compound interest, when one is urging that forests be planted from the investment standpoint? Unless the use of this rate is carefully qualified and explained, erroneous and undesirable impressions on the part of the casual reader or the laymen are certain to result. Usually these explanations are not made, and the average man is convinced that a forest should pay 6 per cent compound interest to be the equal of the 6 per cent simple interest with which he is familiar. The writer does not believe that a rate of over 4 per cent should be used in computing the costs of growing timber and in support of this submits the following:

If we take a certain sum of money, $1,000 (though any amount can be used and the same results secured), and invest this so that it will yield 6 per cent compound interest, in a period of 50 years, this sum of $1,000 would grow to $18,420.20. Deducting the principal of $1,000, $17,420.20 would remain—a large sum of compound interest only.

What rate of simple interest would have to be earned and saved without further investment over a period of 50 years to equal this interest return of $17,420.20 on an initial investment of $1,000? It would be $348.40 per year, which represents 34.84 per cent. In other words, if a man invests $1,000 and earns 34.84 per cent annually on it, and saves this amount for 50 years, the aggregate will be equal to the sum earned at a 6 per cent compound rate. It will be argued that no man would ever allow this annual income to lie idle, and this is of course true. It will in actuality be reinvested whenever possible in order to bring in additional revenue. Everyone will agree that it is an absolute

impossibility for anyone to foresee or predict even closely how the annual income would be invested, either from the standpoint of amount or of time. If any of it is successfully reinvested the increased returns will amount to a sum larger than the amount received by the 6 per cent rate of simple interest. Yet unless the 6 per cent, or $60, for the first year, is upon being received immediately reinvested at the same rate of interest, and this process kept up till the end of the 50 years, the amount earned finally will have fallen below the 34.84 per cent spoken of previously, or the 6 per cent compound interest. Economic opportunities are too limited to permit of any sums expanding at such a rate for any protracted period of time. Yet this is exactly what we demand of a forest when we use the rate of 6 per cent compound interest. If we admit that it is a practical impossibility for a normal business to earn returns equal to a compound rate of 6 per cent, then it certainly is unfair to say that growing forests must measure up to this standard in order to be classed as a worth while investment. If we hold to this view, just what rate would be acceptable? Since no exact statement can be made for any one form of enterprise, it certainly cannot be stated definitely for the growing of timber. However, the following table will be of some aid at least in this connection. It shows the rates of simple interest necessary to be earned and saved to equal rates of compound interest on an initial sum of $1,000, invested for a period of 50 years.

Rate of compound interest	Value of capital and compound interest	Compound interest	Rate of simple interest to be earned and saved to equal amount in column 3
3	4,383.90	3,383.90	6.76
3.5	5,584.90	4,584.90	9.17
4	7,106.70	6,106.70	12.21
4.5	9,032.60	8,032.60	16.06
5	11,467.40	10,467.40	20.93
5.5	14,542.00	13,542.00	27.08
6	18,420.00	17,420.00	34.84

The 6.76 per cent of simple interest we find is equivalent of 3 per cent compound, figured by the same method as that employed in arriving at the rates of 6 per cent compound and the 34.84 per cent simple interest. We have stated that we expect the man earning 6 per cent annually to reinvest and make something higher than this rate.

Therefore the 3 per cent compound rate is too low. When we use compound interest then, the rate must be somewhere between 3 and 6 per cent. The equivalent of the latter rate seems far out of attainment for the great majority of enterprises that are based on annual returns. Even the annual equivalent of 5 per cent (20.93) seems too high. To the writer it seems that a rate of 4 per cent compound interest is sufficiently high when dealing with forest growing as an investment, and is a rate that in no way discriminates in its favor.

After all the point of greatest importance is the total amount that the investment will return and this can of course be figured when a plantation has been brought to maturity. But if foresters have confidence in stating that it is not necessary for such a venture to return over a rate of 4 per cent compound interest in order to be the equal of an investment yielding 6 per cent annually, it will unquestionably cause many to look upon timber growing in a more favorable light than heretofore.

YIELD TABLE FOR WHITE PINE

By Professor R. R. Fenska

New York State College of Forestry, Syracuse University

During August, 1921, a study was made of sixteen white pine plantations in Rhode Island, Massachusetts, and New Hampshire. These plantations ranged from 27 to 63 years of age and as far as could be ascertained included all plantations over 25 years of age in the three named States and probably comprised 90 per cent of all the older planations in the New England States.

The purpose of the study was to secure data for a white pine yield table from actual plantations established in this country and old enough to give satisfactory and reliable data.

The spacing used in establishing these various plantations varied from 4 feet by 4 feet (Nos. 5 and 7) to 22 feet by 25 feet (No. 4), but in 12 of the plantations either a 6 by 8, 8 by 8, 8 by 10, or 10 by 10 spacing was used.

The land in every case had been previously cultivated for agricultural crops, but the returns were small and led to the establishment of the plantations.

The results show conclusively that a normal white pine plantation does not mature until 60 or 65 years old on Site Quality II. At 25 to 35 years it will yield on an average about 400 board feet per acre annually, while with a 55 to 65 year rotation it will yield over 600 board feet per acre per year.

With the average yield (Table 2) indicated by this study and present prevailing stumpage values it is evident that the growing of white pine in the New England States is a profitable enterprise.

DATA

In each plantation the following data were taken on the ground:

Area—Determined by pacing, except where this had already been established by owner or previous measurement.

TABLE 1.—*White Pine Plantations in New England.*

No.	Location	Area (acres)	Site	Age (years)	Trees per acre	Av. d. b. h.	Av. height	Current annual growth per cent[1]	Mean annual growth per acre (b. f.)	Volume per acre: Cu. ft.	Volume per acre: Cords	Volume per acre: Board feet
1	Rhode Island..........	40	II+	27	580	7.0	32	3.3	413	2,049.6	24.44	11,160
2	New Hampshire.......	4	II+	28	200	11.5	43	5.0	440	2,305.1	25.43	12,320
3	Rhode Island..........	9	II	35	212	10.5	35	2.4	365	2,241.2	25.12	12,760
						Average 25–35 years.......406 b. f. per acre per year.						
4	New Hampshire.......	1	II	36	109	11.3	39	5.0	187	1,230.8	13.52	6,740
5	New Hampshire.......	2½	II+	42	1,016	6.0	46	4.2	553	4,220.0	50.81	23,230
6	New Hampshire.......	10	II	42	576	7.0	45	3.2	370	2,536.8	32.56	15,560
7	Massachusetts	2	II	45	524	8.0	43	2.8	427	3,156.4	39.60	19,200
8	New Hampshire.......	2	II+	45	584	9.0	55	2.0	816	5,935.0	65.50	36,710
						Average 36–45 years.......470 b. f. per acre per year.						
9	Massachusetts	12	II	46	520	8.8	45	2.8	662	3,819.6	43.68	30,460
10	Massachusetts	2	II	48	344	9.8	54	4.0	517	4,040.0	44.32	24,840
11	Massachusetts	4	II	50	536	7.7	52	1.8	506	3,917.6	45.56	25,320
12	New Hampshire.......	2½	II+	50	540	8.3	64	3.3	745	5,688.9	63.07	37,260
						Average 46–55 years.......607 b. f. per acre per year.						
13	Massachusetts	1¼	II	57	460	9.5	57	2.5	704	6,203.8	66.97	40,130
14	Massachusetts	2	II	61	248	12.0	57	2.2	531	5,291.2	55.60	32,420
15	Massachusetts	7	II	61	332	11.1	54	3.0	493	4,979.2	53.92	30,100
16	Massachusetts	2	II	63	420	10.5	65	2.3	705	6,880.4	73.40	44,440
						Average 56–65 years.......608 b. f. per acre per year.						

[1] Per cent growth of average tree, by Schneider's formula.

Site—Three qualities of site were recognized.[1]

Quality I—Good—sandy loam.
Quality II—Intermediate—loamy sand.
Quality III—Poor—sandy soil.

All of the plantations studied were of the Quality II site in the above classification though in some cases the soil was a little better than the average (indicated by a plus in Table 1).

In every case the plantation occupied abandoned farm land which the owners had found unprofitable for agricultural crops.

Age—The date of the establishment of each plantation was secured from the owner or from other reliable sources. This was checked by taking borings six inches from the ground of several trees in each area.[2]

Trees per Acre—Determined by actual count from measured quarter-acre sample areas.

Average D.B.H.—Diameters breast high of all the trees on the sample plot were taken with a diameter tape. The average diameter was determined in the field to the nearest inch by inspection of the stand table for the sample plot, later corrected to the nearest tenth (0.1) of an inch for each plot by the mean volume tree method.

Average Height—Determined in the field by measuring the height of several trees with an abney hand level graduated in per cent.

Per Cent Current Annual Growth—Borings of the average tree in each sample plot were taken breast high with an increment borer and the number of annual rings counted in the last inch of growth. Then by the use of Schneider's formula $(\frac{400}{D \times N})$[3] the current annual growth was determined as given in Column 9 of Table 1. This is included merely to give an indication of the *present* status of the different stands, as indicated by the average d.b.h. in each plantation.

[1] It is a well-recognized principle that height is a reliable index of site quality but the various spacings used in establishing these plantations made it necessary to take additional factors, such as character of soil, volume growth per acre and density of stand, into consideration.

[2] The writer has made a distinction between age of a stand and age of a plantation; the difference being the age of the planting stock. In this article the age of the plantation is used throughout since the seedlings for these plantations were gathered mostly from the surrounding fields and woodlots, and therefore probably varied in size and age.

[3] Graves' "Forest Mensuration," p. 307. Chapman's "Forest Mensuration," p. 431.

Mean Annual Growth—Determined by dividing the total board feet per acre (as determined by average quarter-acre sample plots) by the age of the plantation.

Density—Taking the area occupied by the tree crowns and the condition of the forest floor as a criterion of normalcy, all the plantations were normal or fully stocked at the time the plantations were studied.

Volume Tables—The white pine volume tables in "Forest Mensuration" (Mass. Division of Forestry, 1921) were used in computing the number of cords, cubic feet, and board feet content per acre for these plantations.

Table 1 is a compilation of the data for the sixteen plantations studied.

The age and volume per acre for the different plantations given in Table 1 were then plotted on cross-section paper on which the ordinates represented volume (cubic feet, cords or board feet) per acre and the abscissæ the age of the corresponding plantations. Through these points curves were drawn representing the average volume of all these plantations and from these curves the values for Table 2 were read off.

TABLE 2.—*Normal Yield Table, Eastern White Pine, Quality II Site.*

Age (years)	Board feet	Standard cords	Cubic feet
25	6,200	15.3	1,200
30	11,500	23.6	1,980
35	16,600	31.2	2,750
40	21,500	38.4	3,475
45	26,000	44.8	4,175
50	30,100	50.8	4,800
55	34,000	56.4	5,375
60	37,400	61.8	5,900
65	40,400	66.7	6,350

SUMMARY

In only five of the plantations (Nos. 5, 6, 7, 11, and 14) was there any attempt made at a thinning and in all of these (except No. 14) only the dead and badly suppressed trees were removed. In No. 14 a thinning was made in 1908 when about one-third of the trees were removed, yielding 14,000 board feet of box-boards and 40 cords of wood, which yielded a net profit of $20 per acre.

A white pine plantation in New England on Site Quality II soil yields its maximum volume with a rotation of 60 to 65 years.

The mean annual growth per acre increases from 400 board feet per acre with a 25 to 35 year rotation to 600 board feet per acre with a 55 to 65 year rotation.

The maximum financial returns are with a 50-year rotation when with the average yield (Table 2) indicated by this study and *present stumpage values* ($10 to $14 per M) the growing of white pine will yield at least 5 per cent compound interest on the investment, even under our present system of forest taxation.

GROWTH OF SPRUCE AND BALSAM IN THE ADIRONDACKS[1]

By A. B. Recknagel

The key to forest management is a knowledge of growth. Realizing this, the writer undertook, in July of this year, to ascertain the rate of growth in red spruce and balsam fir in the Adirondacks, following an earlier cutting for softwoods. The conditions for such a study were particularly favorable. Thirty years ago a large area near Newcomb, N. Y., was logged for spruce to an approximate diameter of 10 inches on the stump. The cutting was for saw timber. Part of this area now belongs to Robert C. Pruyn, of Albany, and part has recently been acquired from the MacIntyre tract by Finch, Pruyn & Co., of Glens Falls.

Mr. Pruyn has sold his softwood stumpage to the International Paper Company, who are cutting the spruce to 9 inches on the stump and the balsam to 7 inches. The contractor is F. A. Gaylord, of Ne-ha-sa-ne. He kindly gave permission for this study of growth. H. L. Churchill and T. H. Crawshaw, of Finch, Pruyn & Co., together with P. A. Herbert, a recent graduate of Cornell, and the writer did the field work in July, 1922.

The detailed instructions for the study are contained in Appendix A. The object, it will be noted, is to ascertain the current annual growth or increment following the conservative cutting of 30 years ago. This, it was felt, is of more direct utility than figures of growth based on virgin stands.

The cutting of 1892 was confined to the lower land, so the study perforce excluded the upper spruce slope type. Also there was no true swamp type on the area. But, after all, the chief commercial types are the spruce flat and the hardwood slope and on these were measured 224 spruces and 176 balsams, equally divided between the two types.

In addition to the measurements recorded in the instructions, it was found practicable to get the total height of 50 trees as they lay on the ground; a more accurate method than the use of hypsometers. The

[1] Paper read at the meeting of the New York Section of the Society of American Foresters, August 16, 1922.

study of stump tapers could be omitted, since Mr. Churchill had already covered this completely.

The field work progressed very rapidly and offered absolutely no difficulties. Then came the task of computing the results. Fortunately, the same personnel did this, accepting the hospitality of Finch, Pruyn & Co.'s office for the purpose. Detailed instructions for the computations are given in Appendix B, and these were followed literally.

The final results are set forth in the subjoined tables. Although these are self-explanatory, they deserve some comment. The growth is expressed in current annual increment per cent determined by Pressler's well-known formula $\frac{V - v}{V + v} \times \frac{200}{n}$, wherein V is the volume now and v the volume n years ago.

It will be noted that two sets of figures are given. One is based on the last inch of radius (here n is variable), the other on the growth in radius since 1892 (here n is 30). The former is a better index to present volume growth; the latter to growth over the entire 30-year period.

TABLE 1.

Diameter breast high (inches)	Current annual increment, per cent (based on last inch of radial growth)							
	Spruce flat type				Hardwood type			
	Red spruce		Balsam fir		Red spruce		Balsam fir	
		Years to grow last inch of radius (curved)		*Years to grow last inch of radius (curved)*		*Years to grow last inch of radius (curved)*		*Years to grow last inch of radius (curved)*
1	4.6		5.0		4.8		5.8	
2	4.5		4.9		4.7		5.7	
3	4.4		4.8		4.6		5.55	
4	4.3		4.7		4.5		5.4	
5	4.2		4.6		4.4		5.2	
6	4.05	..	4.5	18	4.3	..	5.0	..
7	3.9	17	4.4	16	4.1	20	4.8	..
8	3.8	17	4.3	14	3.9	19	4.6	17
9	3.7	16	4.2	14	3.8	17	4.3	15
10	3.6	15	4.0	13	3.6	15	4.1	14
11	3.4	14	3.8	13	3.3	14	3.8	12
12	3.3	14	3.6	12	3.1	13	3.5	11
13	3.1	13	3.4	12	2.8	12	3.15	10
14	3.0	12	3.1	12	2.5	11	2.8	9
15	2.8	12	2.7	11	2.2	9	2.5	8
16	2.6	12	2.4	11	1.9	7	2.2	8
17	2.4	12	1.95	10	1.6	..	1.9	8
18	2.2	12	1.5	9	1.3	..	1.5	7
19	2.0	..	1.0	..	...	..	1.1	..
20	1.7	..	...	..	...	..	...	..
21	1.5	..	...	..	...	..	...	..
22	1.3	..	...	..	...	..	...	..

TABLE 2.

Diameter breast high (inches)	Current annual increment, per cent (based on radial growth during past 30 years)			
	Spruce flat type		Hardwood type	
	Red spruce	Balsam fir	Red Spruce	Balsam fir
6	4.8	4.7	4.9	5.5
7	4.7	4.6	4.8	5.4
8	4.5	4.5	4.6	5.3
9	4.4	4.4	4.5	5.2
10	4.2	4.2	4.4	5.1
11	4.0	4.1	4.2	4.9
12	3.8	4.0	4.1	4.8
13	3.6	3.8	3.9	4.6
14	3.4	3.7	3.7	4.5
15	3.2	3.5	3.5	4.3
16	3.0	3.3	3.2	4.0
17	2.7	3.1	2.9	3.7
18	2.5	2.8	2.4	3.3
19	2.2	2.4	1.8	2.6
20	1.9	...	...	...
21	1.6	...	...	...
22	1.3	...	...	...

Conclusions might be drawn from the figures that: (1) Balsam fir has a uniformly higher growth rate than spruce. (2) The growth of both species, except for the bigger spruces, is better on the hardwood type than on spruce flats. (3) The growth rate during the entire 30-year period averages in excess of that for the last inch in radius. (4) The average current growth (applying these figures to the average of accurately measured acres in the adjacent uncut stand) is as follows:

Forest type..................	Spruce flat		Hardwoods	
Species	Red spruce	Balsam fir	Red spruce	Balsam fir
Stand per acre—*cords*......	19.477	7.873	6.17	4.88
Annual growth—*cords*......	.616	.253	.17003	.1818
Annual growth—*per cent*....	3.11	3.21	2.76	3.73

The detailed field data and computations are on file in the Albany office of the Empire State Forest Products Association, including three permanent one-acre plots of which two are on cutover lands and one on the adjacent uncut lands. These plots are to be remeasured in 1927.

Appendix A.—Plan for Measurements to be Made on Second Growth of Spruce and Balsam on R. C. Pruyn Tract, Newcomb, N. Y.

Purpose: To ascertain rate of growth of red spruce and balsam fir.

Procedure: Take only sound stumps of average height on recent cuttings on areas previously cut some 30 years ago.

Differentiate measurements according to *types,* i. e. (1) spruce flat, (2) hardwood slope, (3) spruce slope, (4) balsam swamp.

On each stump make the following measurements:

1. Diameter outside bark—inches and decimals.
2. Diameter inside bark—inches and decimals.
3. Stump height—feet and decimals.
4. On average radius, carefully determined, *count back* from the outside of the tree 1 inch, 2 inches, 3 inches, etc., until 30 years have been reached.

Tally as follows:

Stump number	D. o. b. stump	D. i. b. stump	D. b. h. by tapers	Number of rings of growth on average radius				Diameter i.b. 30 years ago (inches) (*c*)
				1 Outside inch	2 Next inch	3 (*a*)	4 (*b*)	
14	12.6	12.3	11	14	12	4 .6″	....	7.1
15	10.6	10.6	9.5	12	10	8 .8″	....	5.0

a 3 or 4 or even 2 may be fractions. Stop counting at the 30th ring of growth and record fraction of inch.

b From curves locally prepared.

c Double the radius at 30 years on diameter already selected.

Instruments:

Calipers—2 pairs.
Diameter tape (for irregular trees).
Hand lens.
Knife.
Rulers—2 (steel).
Notebooks, pencils, erasers.
100 feet tape } for height.
Hypsometer }

Appendix B.—Instructions for Working Up Data on Growth of Spruce and Balsam on R. C. Pruyn Tract, Essex, N. Y.

I.

1. Keep computation for balsam and spruce separate throughout. Also keep data for hardwood type and spruce flat type separate.

2. Tabulate separately by d.i.b. classes (7.6–8.5 inches, inclusive, for example) the following data:

(*a*) D.o.b.—inches.

(*b*) D.i.b.—inches (the difference between (*a*) and (*b*) is twice the bark width).

(*c*) Stump height—feet.

(*d*) Number of rings growth in *outside* inch of radius.

(*e*) D.i.b. 30 years ago.

3. Refer, by means of taper curves, each average d.i.b. to the corresponding d.b.h.i.b. Do the same for d.i.b. 30 years ago.

4. Subtract average d.i.b. (2*b*) from average d.o.b (2*b*), and this will give twice the average bark thickness at stump height.

5. Add this to the d.b.h.i.b. to get d.b.h.o.b.

6. Add this to the d.i.b. 30 years ago to get d.b.h.o.b. 30 years ago.

II.

Prepare height curves from measurements of felled trees or from hypsometer measurements.

Refer height for d.i.b.'s to d.b.h. classes. Make table of heights on d.b.h.

III.

From these curves make local volume table based on volume table for spruce in Cary's "Manual," table No. 6, page 237. (Five per cent less for balsam, from local experience.)

IV.

A.—Complete c.a.i. per cent as follows:

(*a*) By Pressler's formula based on time required to grow last inch of radius.

(*b*) By Pressler's formula based on d.b.h. now and d.b.h. 30 years ago.

B.—Curve results and prepare c.a.i. table *for each.*

C.—Prepare table showing number of years required to grow from one inch class (d.b.h.) to the next, harmonized by curves if direct averages are too irregular. This table may, if preferred, show years required to grow last inch in radius.

CURRENT ANNUAL INCREMENT OF RED SPRUCE AND BALSAM FIR IN THE WESTERN ADIRONDACKS

By Harold Cahill Belyea

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The following study was undertaken for purposes of checking the current annual growth of red spruce and balsam in Eastern St. Lawrence County in contrast to certain results from the same species in the central portion of the Adirondack Region.[1] The area chosen for study was located on the south slope of Curtis Mountain, about one and one-half miles east of the eastern end of Cranberry Lake, St. Lawrence County, N. Y. The area was lightly culled for white pine about 40 to 50 years ago. In 1918 the area was logged for softwood to a 9-inch limit (stump) for spruce and balsam and a 12-inch limit for hemlock. In 1921 a second logging operation was carried on over the entire area, removing all sound spruce, balsam, and hemlock down to a 5-inch limit. The interval from 1918 to 1921 was of too short a duration to have any appreciable effect whatever upon the growth of the trees left in the first pulpwood operation.[2]

The following figures on current annual increment are the results of growth studies made during the past four years, averaged and summarized.

The figures apply mainly to the mixed hardwood and spruce swamp types. In the Cranberry Lake section the spruce flat type is so restricted in area as to make it relatively unimportant.

The growing period covered by this study includes only the last 30 years. For the sake of comparison the growth data were just worked up by diameter classes, computing the annual growth per cent by Pressler's method and curving the results. These figures are presented

[1] Tables showing the Current Annual Increment of Red Spruce and Balsam Fir in the Adirondacks on Spruce Flat and Hardwood Type. By A. B. Recknagel, T. H. Crashaw, H. L. Churchill, and P. A. Herbert, Forestry Leaflet No. 23, Empire State Forest Products Association, Albany, N. Y., July 24, 1922.

[2] Recovery of growth of softwoods after logging takes from 4 to 6 years. See The Second Crop of Pulpwood, by H. C. Belyea, Can. For. Jour. XIII; 1836-40. August, 1918.

in Table 1. Following, the weighted current annual increment per cent per acre was computed and the results applied to the respective total volumes per acre to get the current annual increment per acre in cubic feet and cords. See Table 2.

TABLE 1.—*Current annual increment of spruce and balsam near Cranberry Lake, N. Y. (Based on the growth of the last 30 years and Pressler's formula.)*

D. b. h. class in inches	Mixed hardwood type		Spruce swamp type	
	Spruce (based on 1227 trees)	Balsam (based on 210 trees)	Spruce (based on 396 trees)	Balsam (based on 347 trees)
	Per cent	*Per cent*	*Per cent*	*Per cent*
6	3.4	5.1	4.0	4.7
7	3.4	5.1	4.0	4.6
8	3.4	5.0	3.5	4.5
9	3.4	4.9	2.9	4.4
10	3.4	4.7	2.4	4.3
11	3.4	4.5	1.7	4.2
12	3.3	4.2	1.1	4.1
13	3.3	3.9	...	3.9
14	3.2	3.6	...	3.6
15	3.1	3.3	...	3.3
16	2.9	2.8	...	...
17	2.7	2.3	...	...
18	2.5	...	...	...
19	2.4	...	...	...
20	2.3	...	...	...
21	2.1	...	...	...
22	1.9	...	...	...
23	1.7	...	...	...
24	1.5	...	...	...
25	1.3	...	...	...

TABLE 2.—*Average current annual increment per acre for spruce and balsam, Cranberry Lake, St. Lawrence County, N. Y. (Based on growth of last 30 years.)*

	Average current annual growth per cent—Pressler	Current annual growth per acre	
		Cubic feet	Cords
Mixed hardwood type—			
Spruce	2.49	34.2	...
Balsam	4.21	1.2	...
Both species	2.50	35.4	.32
Spruce swamp type—			
Spruce	2.80	26.1	...
Balsam	4.58	13.1	...
Both species	3.00	39.2	.43

From the foregoing, several conclusions can be drawn—

1. The average current annual increment of from 2.49 to 4.50 per cent is larger than had been expected for these species under the existing conditions.

2. In the Cranberry Lake section, balsam fir constitutes less than 2 per cent in numbers and less than 3 per cent in volume of the stand per acre in the mixed hardwood type. While it shows a relatively high current annual increment, its net effect toward the total growth in volume per acre per year is relatively small.

3. The values are lower on the whole than those reported from the central portion of the Adirondacks (*loco cit.*), but can be accounted for in part, at least, by a considerable difference in growing conditions during the last 30 years. These particular figures are based on conditions following a light culling operation while those in Essex County were taken on an area which had been cut to a ten-inch limit in 1890-92.

4. The figures for balsam run considerably higher than those for spruce in the corresponding type.

5. The figures for both spruce and balsam run higher in the swamp type than on the upland.

6. The irregular variations from diameter class to diameter class in the uncurved growth per cent values are indicative of the severe degree of competition prevailing in the climax forest.

METHODS OF DETERMINING YIELD IN EVEN-AGED YELLOW PINE STANDS

By S. B. Show

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In July, 1919, in connection with the establishment of a yield plot in a stand of pure even-aged yellow pine, an opportunity arose for studying some of the more exact European sample tree methods for the determination of volume in such stands. The plot in question, known as the Luman Plot, is located near the Feather River Experiment Station at an elevation of 3,500 feet in a level meadow, and is classed as Site I in quality. The stand is 56 years old and is pure yellow pine with a very few small poles of incense cedar and Douglas fir, which do not, however, form a part of the main stand.

METHOD OF WORK

An area of one acre with a suitable isolation strip was laid out and all trees 3.6 inches in diameter and over were tagged, the diameters measured, and the usual descriptive notes recorded. The heights on about 50 per cent of the trees were taken, using the Forest Service hypsometer for this purpose.

In order to determine the volume of timber on the area five of the European sample tree methods, as described in Graves' "Forest Mensuration," were used. These were the Hartig, Urich, Metzger, Mean Sample Tree, and Form Factor of Mean Sample Tree Method. The make-up of the stand is shown in Table 1. It will be seen that there are a total of 618 trees well distributed in the different diameter classes, that the basal area was 330 square feet, and that the height of the larger trees was about 90 feet. It is evident from this that the plot is on an excellent site and tends toward over rather than understocking. A comparison of the methods is shown in Table 2.

The Hartig method of determining volume assumes the division of the entire stand into a number of groups having equal basal areas. This having been done, the diameter of the average tree in each group is computed from basal areas, and sample trees are selected for measurement for volume. Four classes were used in the present work, as shown

in Table 2. Since it is undesirable to fall trees in plots under study, most of the volumes were secured by climbing the trees and securing measurements at every 8 feet. In the case of some of the trees too small to climb, trees outside the plot were cut and measured.

TABLE 1.—*Luman Plot.—Summary of Stand.*

D. B. H.	Number of trees	Heights measured	Average height	Height curved	Number of sample trees	Average form factor	Total basal area
4	68	36	33.3	34.3	3	.596	6.140
5	76	39	40.9	40.8	8	.514	10.649
6	64	32	48.6	46.5	7	.500	12.718
7	52	29	51.8	52.0	6	.475	14.242
8	59	31	55.0	56.5	7	.452	20.417
9	39	23	62.7	61.0	7	.448	16.787
10	53	28	65.0	65.0	4	.461	28.950
11	34	15	71.0	68.6	1	.490	23.460
12	40	18	73.5	71.8	3	.458	31.906
13	39	20	72.0	75.0	1	.430	35.959
14	26	13	77.0	78.0	1	.457	28.345
15	30	19	77.7	80.8	2	.416	36.522
16	15	8	80.0	83.3	2	.397	20.914
17	7	4	84.0	86.0	1	.402	11.223
18	9	8	91.0	88.2	..	....	16.167
19	2	1	93.0	90.2	..	....	3.981
20	3	1	102.0	92.0	..	....	6.656
21	1	...	.....	93.8	..	....	2.360
22	1	1	94.0	95.5	..	....	2.616
Total...	618	326	.....	....	53	....	330.012

From the 340 height measurements taken on the plot a very satisfactory height-diameter curve was constructed, and in the selection of all sample trees individuals were picked which corresponded as nearly as possible to the average height for the diameter.

The Urich method also depends on dividing the stand into a number of groups, but using groups with equal numbers of trees instead of equal basal areas. A new bunch of sample trees was selected and measured in accordance with the sizes indicated in the different tree groups.

The Mean Sample Tree method considers the entire stand as one group, so that trees of only one diameter are selected for measurement.

The use of the Form Factor of the average tree gives practically identical results with those obtained by the use of the volume of average trees.

TABLE 2.—*Volume Computations by Different Methods.*

Class	Diameter group	D. b. h. of average tree	No. of trees	Average height	No. of trees measured	Average form factor	Volume: Small trees	Volume: Large trees	Volume of average tree or sample	Total volume	Basal area in class
	Inches	*Inches*		*Feet*			*Cu. ft.*		*Cu. ft.*	*Cu. ft.*	*Sq. ft.*
HARTIG METHOD.											
1	3.6–9.6	6.4	361	49	3	....	....	....	5.14	1,855	82.462
2	9.7–12.5	11.0	124	69	4	....	....	....	21.54	2,670	82.807
3	12.6–14.8	13.7	80	77	2	....	....	....	35.72	2,860	82.069
4	14.9–21.9	16.9	53	86	2	....	....	....	54.60	2,895	82.682
Total...	....	....	618	....	....	....	....	....	....	10,280	330 020
URICH METHOD.											
1	3.6–5.8	4.7	157	39	3	....	....	....	2.466	387	19.108
2	5.9–8.4	7.2	152	52	4	....	....	....	6.79	1,032	43.217
3	8.5–12.0	10.1	154	65	4	....	....	....	16.64	2,562	85.385
4	12.1–21.9	14.7	155	80	3	....	....	....	40.42	6,265	182.303
Total...	....	....	618	....	....	....	....	....	....	10,246	330.013
MEAN SAMPLE TREE METHOD.											
....	....	10.0	618	65.8	4	....	....	....	16.64	10,280	330.012
FORM FACTOR OF AVERAGE TREE.											
....	....	10.0	618	65.8	4	.461	....	....	16.6	10,260	....
METZGER METHOD.											
....	....	....	618	....	10	....	18.008	151.140	169.15	10,450	....

The Metzger method, which was the last one used on the plot, subdivides the trees into two general groups: the large trees are those with diameters greater than the average for the entire stand, and small trees those with diameters smaller than average. This method is less mechanical in its operation, depending upon the judgment in selecting the sample trees in these two broad groups, whereas in the other methods the sample trees, in so far as size is concerned, are picked mechanically.

Altogether a total of 53 sample trees were carefully measured, these ranging in diameter from 4.0 inches to 16.9 inches. Table No. 3 shows the computed volume on the plot for each of the five methods employed. It will be seen that there is a remarkable uniformity of values—the extreme deviation from the mean value only 1½ per cent. At the time the work was done it was not anticipated that any such conformity of results would be obtained, and in fact the computations were not undertaken until after all of the field work, including the selection and measurement of sample trees, had been computed. So far as can be learned, such a close conformity of results is rather unusual under the best of circumstances and with skilled practitioners doing the work. Neither Munns nor the writer, who carried out the present job, had previous experience in this particular line of investigation.

On the face of the results of this study any one of the methods appears to give satisfactory results for such studies as this one. It is probably true that several sample trees in each class should be selected, for it was found that a variation of around 10 per cent in volume exists in trees of the same diameter and height. Therefore, if only one tree in the class was selected, the opportunities for error would be considerable.

TABLE 3.—*Summary.*

Method	*Volume cu. ft.*	*Deviation percent*
Hartig	10,280	—0.19
Urich	10,240	—0.58
Mean sample tree	10,270	—0 29
Form factor of average tree	10,260	—0.39
Metzger	10,450	+1.45
Average	10,300	.....

TABLE 4.—*Summary of Dead Trees.*

Cause of death	*Number of trees*	*Average D. b. h.*
Snow	53	6.0
Insects	15	6.9
Suppression	75	4.3
Total	143	5.2

In tagging the trees on the plot a tally was kept of all dead trees and the results of this are shown in Table 4. Snow, both by bending trees over and by breakage, was responsible for the death of 53 trees within the past few years, these averaging 6 inches in diameter. Insects have killed 15 trees, averaging nearly 7 inches, and suppression has been responsible for the death of 75 trees, with a diameter of a little over 4 inches. There is no way of telling how long a period this record covers. It was estimated at the time that five years was the correct figure, but it would be of great interest to follow the death rate in this stand during subsequent remeasurements.

From the measurements of the sample trees two charts were constructed, to show form factor on the basis of diameter and total height. Starting with a high form factor nearly 600 in the 4-inch class, the curve drops rapidly to a diameter of about 6 inches, after which it flattens out somewhat and the form factor decreases fairly regularly at the rate of about .006 for each increase of one inch in diameter. The form of the curve, by the way, is essentially similar to that determined in investigations of second growth in sugar pine and white fir. The curve of form factor on the basis of total height is somewhat different from that for form factor on diameter, but shows a decrease with increase in size of the trees.

DETERMINATION OF THE ANNUAL CUT ON A SUSTAINED BASIS FOR VIRGIN AMERICAN FORESTS

With Specific Reference to the Pacific Coast Region

By E. J. Hanzlik

U. S. Forest Service

The importance of cutting National Forest timber on a sustained basis has been recognized by the Forest Service ever since the management of these forests was placed in its charge, and all plans for the sale of such timber are based upon a limitation of cut by individual forests whereby the annual cut is limited to a certain figure set by the Secretary of Agriculture. The determination of this annual cut has been based generally upon rather superficial timber data and a rough figure obtained by using the Von Mantel formula, $Y = \frac{V}{\frac{1}{2}r}$, where Y is the annual cut, V the mature timber volume, and r the number of years in the rotation. This formula allows rapid calculation with a minimum of necessary data, and for large forest units, such as a National Forest of from 500,000 to one million acres, no doubt a fair degree of accuracy is obtained. For smaller areas, however, comprising watersheds of from 20,000 to 100,000 acres, this formula has been found liable to give absurd results, especially where there is a preponderance of the mature age-classes in the forest. Other European formulæ have been tried out in this country, but for the most part they have not been found to be of much practical use in our virgin forests.[1]

The Forest Service is now at the point where forest management plans are required in greater detail for individual working circles before cutting operations are instituted, and the drawing up of these plans necessitates a more thorough knowledge of timber conditions, sites, age-classes, etc., within the area than were available for the determination of the cut for the individual National Forests. It is the use of this

[1] For a description of European formulæ see Schlich's "Manual of Forestry" Vol. III, Forest Management, pp. 317; or "Forest Management," by Recknagel & Bentley, pp. 146.

greater detail over a smaller area which obviates the use of these European formulæ in calculating the allowable cut on a sustained basis in typical forests in the United States and Canada.

The Pacific Coast forests, especially those of western Oregon and Washington, present a condition generally far from the ideal or normal forest such as is the ultimate goal of the forester, the ideal forest which is an objective but which probably never will be attained. However, with this ideal or normal forest in mind, the American forester can evolve a system which will gradually approach this theoretical forest and at the same time place the forest upon a continuous revenue-producing basis from the start.

WORKING CIRCLES

In the Pacific Coast forests a working circle, as a unit of sustained yield management, as a rule will comprise a compact body of timber which is tributary to some central point for manufacture or for distribution of the manufactured product within reasonable access of the area. The amount of timber within this circle should be sufficient to warrant development within the forest and at the central point for manufacturing purposes if desired, to be determined by the existing conditions in the region such as market conditions, local logging and milling practice, costs of development, etc. In the Douglas fir region for the next decade or two a sustained cut of 10 million feet annually will probably be the minimum amount prescribed, generally it will probably range from 15 million feet annually upward; the size of the working circle varying from about 20,000 acres up to 200,000 acres or even more in some instances.

It is, of course, preferable to have all the timber within a working circle under a single ownership at the time the cut is determined, but for practical purposes it is not necessary since in most cases a consolidation of ownership is either contemplated or is to some extent consummated before operations are started.

DATA REQUIRED

The sustained annual cut for any working circle is dependent upon the following factors, all of which should be determined during the course of the field examination:

1. Total productive forest area.

2. Site, or productive capacity of the soil for forest crops.
3. Total estimated stand of loggable mature timber.
4. Area of various age classes, and approximate degree of stocking of the immature timber as compared to normal stocking to be determined by reference to standard yield tables applicable to the region and site.

Other data or information necessary is that pertaining to the technical features, such as:

1. Normal or standard yield tables for the species to be grown which are applicable to the forest region in which the working circle is located.
2. The use to which the present forest crop is to be put; such as lumber, posts, ties, etc., for a determination of the technical rotation.
3. The soil expectation value (Se) for the area and species expected to be grown in order to determine the financial rotation.

A METHOD FOR VIRGIN AMERICAN FORESTS [2]

A working circle in the typical virgin American forest will usually consist of one watershed or a number of watersheds from which the timber may be considered tributary to some one central point for manufacture or for distribution to distant markets. Within this working circle various types and ages of timber will be found; in the Douglas fir region of western Oregon and Washington the forest being typically of the even-aged character, and composed of a number of age-classes. These age-classes are found distributed throughout the circle without any regularity as to size or location, being merely accidental in their ocurrence and extent as a result mainly of fires. Generally the mature timber runs from 250 years of age upward with an understory of inferior growth, which is not deemed of sufficient value to be preserved for the next crop. Therefore within the mature timber area it may be considered that the growth is stagnant, while in the immature age-classes a certain increment is being added annually.

The method of determining the annual cut as advanced here takes into consideration the present mature timber volume and the increment of the immature stands, and is represented by the formula $Y = \frac{Vm}{r} + I$, where Y is the sustained annual yield, Vm

[2] All the details and calculations are based on conditions and data for the western Cascades region of Oregon and Washington, where Douglas fir is the predominant species.

the merchantable mature timber volume above the rotation age, r is the number of years in the rotation, and I is the actual mean annual increment of the immature timber for the rotation. If, for example, a tract is composed of mature timber only it is evident that in putting it under management for a sustained yield that the annual cut would be equal to $\frac{Vm}{r}$ for the first rotation in order to have another crop of loggable timber available when the present mature timber is all cut. If, in addition there is present a certain amount of immature timber composed of various age-classes which is making a certain annual growth, this annual increment I, should be added to the cut obtained by $\frac{Vm}{r}$, and the possible annual cut, Y, is obtained, the formula becoming $Y = \frac{Vm}{r} + I$.

METHOD OF APPLICATION

To illustrate the workings of the formula and also a system for checking its accuracy, a typical working circle in western Oregon is used as an example. As mentioned previously a rather detailed examination of the area is necessary, by which the following data were obtained:

Data

1. Productive forest area = 185,000 acres.
2. Quality of Site = Site II, Western Cascades.
3. Mature timber volume (Vm) = 4,000,000 M feet b.m.
4. Area of age classes.

Mature	110,000 acres	
80 years......	31,000 acres	75,000 acres immature.
40 years......	6,000 acres	
10 years......	38,000 acres	
	185,000 acres	

5. Degree of stocking of immature timber = 60 per cent of normal or standard tables.
6. Rotation (r) = 80 years.

I, the actual mean annual increment of the present immature stands for the first rotation, is obtained by assuming that it is equal to a summation of the increments for each age-class at one-half the rotation following the present age; in this case 40 years later than the present ages. In addition, during the field work a comparison must be made of

the stocking of the immature stands with the standard yield tables, as usually the average immature stand is under-stocked in comparison to the stands in which data were obtained for the yield tables. Generally for any considerable area, in the Douglas fir region, the average stocking is about 60 per cent to 75 per cent of that given in the standard tables. The mean annual increment, I, is obtained as follows:

Calculation of Mean Annual Increment, I, for 80-Year Rotation.

Present age of stand	Area	Age at ½ r (40 years hence)	M. A. I. at ½ r from std. yield table[3]	M. A. I. of immature stands at ½ r. 60 per cent stocking	Total M. A. I. ½ r. 60 per cent stocking
Years	*Acres*	*Years*	*Ft. b. m. per acre*	*Ft. b. m. per acre*	*M feet b. m.*
10	38,000	50	430	258	9,800
40	6,000	80	625	375	2,200
80	31,000	120	673	404	12,500
....	75,000	....	....	....	24,500 = I

[3] See Mss. Report, "A Study of the Growth and Yield of Douglas Fir on Various Sites in Western Washington and Oregon," U. S. F. S. By E. J. Hanzlik, Mar. 14, 1912. Tables also in Forestry Quarterly, Vol. XII, pp. 440-51.

The above calculations give the following data for use in obtaining Y:

Vm = 4,000,000 M feet b.m.
I = 24,500 M feet b.m.
r = 80 years.

Substituting in the formula $Y = \frac{Vm}{r} + I$, we get $Y = \frac{4,000,000 \text{ M}}{80} + 24,500$ M whereby an annual cut of 74,500 M feet b.m. is obtained. For an 100-year rotation I is obtained as follows:

Calculation of Mean Annual Increment for 100-Year Rotation.

Present age of stand	Area	Age at ½ r (50 years hence)	M. A. I. at ½ r std. yield table	M. A. I. of immature timber at ½ r. 60 per cent stocking	Total M. A. I. at ½ r. 60 per cent stocking
Years	*Acres*	*Years*	*Ft. b. m. per acre*	*Ft. b. m. per acre*	*M feet b. m.*
10	38 000	60	534	320	12,150
40	6 000	90	640	384	2,300
80	31 000	130	665	399	12,350
....	75 000	....	....	....	26,800 = I

The annual cut Y in this case, therefore, is $\frac{4,000,000 \text{ M}}{100} + 26,800$ M,

or 66,800 M feet b.m., as against a cut of 74,500 M feet b.m. when based on an 80-year rotation.

As a method of checking the results obtained by the formula the process of tracing out the different age-classes for each decade during the first rotation is presented here. In this manner, by applying yield data suitable to the area, a check may be had against any unreasonable figure that sometimes undoubtedly may be obtained by using the formula. The data used are as follows:

Mature timber area,	110,000 acres	4,000,000 M. ft. b. m.
80-year age-class,	31,000 acres	
40-year age-class,	6,000 acres	
10-year age-class,	38,000 acres	
Total forest area	185,000 acres	

Cutting in the mature timber is assumed to have started in 1920 at the rate of 75 million feet per year, or 750 million feet per decade. To simplify the calculations the entire area is classed as Site II, Douglas fir forest region for which standard yield tables are available, and it is assumed that an equal area of mature timber is cut each year. From an examination of the immature timber it is estimated that it is about 60 per cent stocked as compared to the standard yield tables for similar sites, this indicating that a reduction of 40 per cent must be made from the standard tables in predicting future growth.

With a stand of 4 billion feet b.m. and a cut of 75 million feet per year, the mature timber will be cut out in 53 years; and the 110,000 acres of mature timber will be cut at the rate of 2,080 acres per year or 20,800 acres per decade. Illustrating this in tabular form the data can be presented as follows:

In 1921 (start of cutting)

Mature timber	110,000 acres	4,000 million ft. b. m.
80-year class	31,000 acres	
40-year class	6,000 acres	
10-year class	38,000 acres	

1921 to 1930 (1st decade)

Cut 20,800 acres mature timber (750 million feet) leaving in 1940 of 1930 there remains 110,000 acres less 20,800 acres or

89,200 acres mature timber with	3,250 million feet
90-year class, 31,000 acres x 34,800 feet per acre =	1,080 million feet
50-year class, 6,000 acres x 12,900 feet per acre =	80 million feet
20-year class, 38,000 acres, negligible volume.	
5-year class, 20,800 acres, negligible volume.	
Total	4,410 million feet

Since the greatest portion of Douglas fir reproduction springs up naturally within the first year after logging, provided the slash is burned immediately, the average age of the new crop at the end of the first decade is taken to be five years, as the age of the young trees will range from 0 years to 9 years. For practical purposes 5 years can be taken as the average age at the end of the first decade and no appreciable error will creep in which will affect the results.

Illustrating further:

1931 to 1940 (2d decade)

Cut 20,800 acres mature timber (750 million feet) leaving in 1940

Mature, 68,400 acres containing	2,500 million feet
100-year, 31,000 acres x 39,600 feet =	1,230 million feet
60-year, 6,000 acres x 19,200 feet =	120 million feet
30-year, 38,000 acres negligible volume.	
15-year, 20,800 acres negligible volume.	
5-year, 20,000 acres negligible volume.	
Total	3,850 million feet

The tabulations indicate that the immature growth is increasing in volume each decade with increased years, this being based on the volume indicated for each age-class in the standard yield tables, an allowance of 40 per cent however being deducted due to the stands being understocked. In predicting the volumes, however, on the areas cut since 1920 which will be under protection from the time of cutting, it may safely be assumed that the yield will approximate that indicated in the yield tables, although in these calculations a safety-factor of 10 per cent is used, the calculations showing a yield equal to 90 per cent of that given in the standard Douglas fir tables.

At the rate of 75 million feet b.m. per year the mature timber will last 53 years, at which time the 31,000 acres of young timber (80 years old in 1920) will have attained an age of 133 years with an estimated stand of 1,610 million feet at the commencement of that decade. Thus for the 6th decade (from 1971 to 1980) the cut will be as follows:

1971 to 1981

Mature timber, 6,000 acres	250 million feet
130-year age-class, 9,600 acres x 51,900 feet	500 million feet
Total	750 million feet

This leaves at the end of the decade (in 1980) the following age-classes, areas and timber volumes:

140-year age-class 21,400 acres x 54,900 per acre =	1,170 million feet
100-year age-class 6,000 acres x 39,600 per acre =	240 million feet
70-year age-class 38,000 acres x 24,900 per acre =	950 million feet
55-year age-class 20,800 acres x 24,200 per acre =	500 million feet
45-year age-class 20,800 acres x 15,200 per acre =	310 million feet
35-year age-class 20,800 acres negligible volume	
25-year age-class 20,800 acres negligible volume.	
15-year age-class 20,800 acres negligible volume.	
5-year age-class 15,600 acres negligible volume.	
Total	3,170 million feet

It is assumed in these calculations that the cut-over areas are handled in accordance with correct forestry practice and that satisfactory reproduction is obtained the first year after logging operations have taken place. A safety factor of 10 per cent is allowed for uneven stocking, accidents, etc., so that the estimated volumes given here are 10 per cent less than the volumes in the standard yield tables for Quality II Sites.

Referring back to the preceding tabulation it will be seen that starting in 1981 cutting operations will be entirely in 140-year timber as follows:

1981 to 1990 (amount cut)

140-year age-class 13,600 acres x 54,900 feet per acre = 750 million feet.

This leaves in 1990 the following:

150-year age-class 7,800 acres x 57,500 feet =	450 million feet
110-year class 6,000 acres x 44,400 feet =	270 million feet
80-year class 38,000 acres x 30,000 feet =	1,140 million feet
65-year class 20,800 acres x 33,200 feet =	690 million feet
55-year class 20,800 acres x 24,200 feet =	500 million feet
45-year class 20,800 acres x 15,200 feet =	310 million feet
35-year class negligible volume.	
25-year class negligible volume.	
15-year class negligible volume.	
5-year class negligible volume.	
Total	3,360 million feet

The last decade's cutting operations (1991 to 2000) indicate the cut to be from the following classes:

1991 to 2000 (amount cut)

150-year age-class	7,800 acres x 57,500 feet = ...	450 million feet
110-year age-class	6,000 acres x 44,400 feet = ...	270 million feet
80-year age-class	1,000 acres x 30,000 feet = ...	30 million feet
	14,800 Total..........................	750 million feet

This leaves in the year 2000 (the end of the first rotation) the following forest:

Composition of Forest in Year 2,000.

90-year age-class	37,000 acres x 34,800 feet per acre = ...	1,290 million feet
75-year age-class	20,800 acres x 41,200 feet per acre = ...	850 million feet
65-year age-class	20,800 acres x 33,200 feet per acre = ...	690 million feet
55-year age-class	20,800 acres x 24,200 feet per acre = ...	500 million feet
45-year age-class	20,800 acres x 15,200 feet per acre = ...	310 million feet
35-year age-class	20,800 acres negligible volume.	
25-year age-class	15,600 acres negligible volume.	
15-year age-class	13,600 acres negligible volume.	
5-year age-class	14,800 acres negligible volume.	
Total	....	3,640 million feet

The above figures indicate the probable composition of age-classes in the forest at the end of the first rotation, and will show the feasibility of the cut which is obtained by the formula $Y = \frac{Vm}{r} + I$. It is seen also that the forest cover is approaching the ideal or normal forest condition as should be found in a well regulated forest, a condition which is to be desired although doubtful whether it can be attained.

By means of a check on the cut such as illustrated in the preceding pages there can be brought out any possibilities of an over-cut, and there may also be indicated the desirability of increasing the cut after one or two decades if it is seen that there will be too great a surplus at the end of the first rotation. The arithmetical check indicates in this instance that an annual cut of 75 million feet b.m. as obtained with the formula $Y = \frac{Vm}{r} + I$ is satisfactory, and the indications are that it might be slightly more, but it appears best to start with a conservative cut which later may be raised if conditions seem to warrant an increase.

The ultimate future sustained annual yield for this circle is estimated at 104 million feet for an 80-year rotation, based on cutting 2,312.5 acres per year with an estimated stand of 45 M feet b.m. per acre.[4] Under an 100-year rotation the estimated future annual yield is equal to 110 million feet b.m. based on cutting 1,850 acres per year with a stand of 59.4 M feet b.m. per acre.[4]

FIXING THE ROTATION (r)

In dealing with the present stands of Douglas fir in the Pacific Northwest we are not so directly concerned with the rotation except as an aid toward obtaining a tentative cut for the life of the mature timber. For three typical working circles, using the formula $Y = I + \frac{Vm}{r}$ and rotations of 80 and 100 years the following annual cuts are indicated:

Working circle	Vm	Y	
		r = 80 yr.	r = 100 yr.
a	2,100,000 M feet	34,950 M feet	30,700 M feet
b	3,180,000 M feet	47,700 M feet	40,500 M feet
c	4,000,000 M feet	74,500 M feet	66,800 M feet

It appears at first thought that 80 years is too short to be considered at this time, and on the face of it there seems to be logical reason to think that a longer rotation should be decided upon. However, even though using 80 years in the calculations, it is found by checking the cut by decades that generally after the mature timber is cut out cutting will thereafter take place in what is now second-growth timber which will be then from 90 to 120 or 130 years of age, and very seldom will cutting have to be done in timber less than 90 years of age, provided the cut is fixed by the formula $Y = I + \frac{Vm}{r}$, letting $r = 80$ years. The annual yield as determined should only apply as a rule during the life of the mature timber and the older age-classes of the immature timber, after which a new calculation for Y should be made for the next rotation, which may or may not be the same as that used in the original calculations.

[4] Allowing 10 per cent safety factor from Site II, Douglas fir yield tables.

In general for Sites I and II in the Douglas fir region an 80-year rotation appears feasible to use in the calculations, while for Site III a rotation of possibly 100 years will give satisfactory results.

MODIFICATIONS OF THE FORMULA

In the foregoing discussion the only factors taken into consideration are the mature volume, the actual mean annual increment of the immature stands, and the rotation. There may be considered still another factor which may have some bearing upon the determination of the annual cut, namely, the normal growing stock. This normal growing stock is, of course, of little practical value at this time in our virgin forests, but it is an indication as to whether or not these forests are over-stocked or under-stocked. By taking this normal growing stock into consideration the formula may be modified by taking account of this surplus or deficit and spreading it over a certain number of years, in which case the annual cut, Y, would be obtained as follows: $Y = \frac{Vm}{r} + I + \frac{Vm - Vn}{x}$, where Vm, I and r have the same values as in the original formula, Vn is the normal volume or normal growing stock, and x is the number of years over which the surplus or deficit is to be spread. In using this modified form, unless x is taken as a long term of years, the result obtained cannot be used throughout the rotation, since the cut in that case usually will be far greater than can be maintained on a sustained basis.

With the same data as a basis as used previously, and calculating Vn, the normal volume, from the standard yield tables a comparison of the two can be made. Vn in this case is as follows:

Calculation of Normal Volume (Vn).

Age-class	Area	Yield per acre[5]	Total stand
Years	*Acres*	*Feet b. m.*	*M feet b. m.*
10	23,125	Negligible	....
20	23,125	Negligible	....
30	23,125	Negligible	....
40	23,125	10,800	250,000
50	23,125	19,400	450,000
60	23,125	28,800	670,000
70	23,125	37,300	860,000
80	23,125	45,000	1,040,000
Totals..........	185,000	......	3,270,000 = Vn

[5] Based on Site II, Douglas fir standard yield tables; allowing 10 per cent safety factor.

Substituting in the formula $Y = \frac{Vm}{r} + I + \frac{Vm - Vr}{x}$

$$\begin{aligned} \text{letting } Vm &= 4{,}000{,}000 \text{ M feet} \\ Vn &= 3{,}270{,}000 \text{ M feet} \\ I &= 24{,}500 \text{ M feet} \\ r &= 80 \text{ years} \\ x &= 20 \text{ years} \end{aligned}$$

we get $Y = \frac{4{,}000{,}000 \text{ M}}{80} + 24{,}500 \text{ M} + \frac{4{,}000{,}000 \text{ M} - 3{,}270{,}000 \text{ M}}{20} =$

$50{,}000 \text{ M} + 24{,}500 \text{ M} + 36{,}500 \text{ M} = 111{,}000$ M feet b.m.

The cut indicated above is undoubtedly too large even for a 20-year period, since in that time 2,200,000 M feet would be removed, leaving a balance of 1,800,000 M feet to be cut plus the increment during the remaining 60 years of the rotation. Using the formula $Y = \frac{Vm}{r} + I$, letting r = 60 years, the number of remaining years to the end of the rotation, we get

$$Y = \frac{1{,}800{,}000 \text{ M}}{60} + 24{,}500 \text{ M, or } 54{,}500 \text{ M feet b.m.}$$

as the allowable cut on a sustained basis for the remainder of the rotation. Such a reduction in the annual cut, practically one-half of the initial cut, is not desirable from the standpoint of a continuous forest operation and, therefore, it cannot be recommended in this instance.

Taking the same working circle and letting x be equal to the number of years in the rotation, the formula $Y = \frac{Vm}{r} + I + \frac{Vm - Vn}{x}$ becomes $Y = \frac{Vm}{r} + \frac{Vm - Vn}{r} + I$, which in turn may be reduced into $Y = \frac{Vm + (Vm - Vn)}{r} + I$. Substituting in the above modification of the formula and using the same data as before the annual cut becomes:

$$Y = \frac{4{,}000{,}000 \text{ M} + (4{,}000{,}000 \text{ M} - 3{,}270{,}000 \text{ M})}{80} + 24{,}500 \text{ M} =$$

$$\frac{4{,}000{,}000 \text{ M} + 730{,}000 \text{ M}}{80} + 24{,}500 \text{ M} = 59{,}100 \text{ M} + 24{,}500 \text{ M or}$$

$Y = 83{,}600$ M feet b.m.

Thus, by extending the period over which the surplus is spread to the number of years in the rotation a more conservative cut is obtained,

while by making x equal to twice the rotation a cut is prescribed about midway between this and the amount obtained with the original formula. A comparison between the original formula and its modifications when x equals r and 2r is as follows:

Formula	r = 80 years	r = 80 years x = 80 years	r = 80 years x = 160 years
$Y = \frac{Vm}{r} + I$	Y = 74,500 M	....	....
$Y = \frac{Vm}{r} + \frac{Vm-Vn}{x} + I$	....	Y = 83,600 M	Y = 79,000 M

By carrying out an area-volume check for these three annual cuts as illustrated for the cut obtained by the formula $Y = \frac{Vm}{r} + I$ (see pages 614 to 619), a decision may be made with reasonable accuracy as to the annual cut which may be safely recommended. Using these three indicated yields for a comparison by the area-volume check the probable composition of the forest in the year 2000 (the end of the first rotation) is of interest and in addition is almost necessary in order to arrive at a conclusion regarding the amount to be cut and to have any degree of confidence in the amount recommended.

The following tabulation shows the probable forest composition for the three indicated yields at the end of the first rotation:

$Y = \frac{Vm}{r} + I$			$Y = \frac{Vm}{r} + \frac{Vm-Vn}{x} + I$					
I Y = 74,500 M r = 80 years			II Y = 79,000 M r = 80 yrs x = 160 yrs.			III Y = 83,600 M r = 80 yrs. x = 80 yrs.		
Age class	Acres	Est. stand, million feet	Age class	Acres	Est. stand, million feet	Age class	Acres	Est. stand, million feet
90	37,000	1,290	90	23,300	810	90	10,000	350
75	20,800	850	75	22,000	910	75	23,000	950
65	20,800	690	65	22,000	730	65	23,000	760
55	20,800	500	55	22,000	530	55	23,000	510
45	20,800	310	45	22,000	330	45	23,000	350
35	20,800	neglig.	35	22,000	neglig.	35	22,100	neglig.
25	15,600	neglig.	25	15,200	neglig.	25	16,200	neglig.
15	13,600	neglig.	15	14,400	neglig.	15	16,700	neglig.
5	14,800	neglig	5	22,100	neglig	5	28,000	neglig.
....	185,000	3,640	....	185 000	3,310	....	185 000	2,920

Comparing these data with those showing the calculation of the normal volume (Vn) on page 621 it is seen that with a cut of 79 million feet annually the forest composition comes closest to the normal forest both in area of age-classes and in the total volume. There are in all cases, however, nine age-classes, while in the normal forest only eight are present. An analysis of the timber volume also indicates that a cut of 79 million feet appears best for the first rotation, since with a cut of 83,600 M feet it undoubtedly will be necessary to cut in the age-classes younger than the rotation age, as there are only 350 million feet of the 90-year class, so that some timber would have to be removed from the 75-year stands during the next decade, and also in the following decades. On the other hand a cut of 74,500 M feet appears to cause a surplus since in the 90-year class there is a stand of 1,290 million feet and 850 million feet in the 75-year class. With this amount, however, there is easily a possibility of increasing the cut during the next rotation so that it will more nearly approach the ultimate sustained cut which eventually can be obtained from the area. It is estimated that this ultimate sustained annual cut for this working circle, consisting of 185,000 acres of Site II forest land will be 104 million feet for an 80-year rotation and 110 million feet for an 100-year rotation.

Taking the above factors into consideration it is seen that the original formula $Y = \frac{Vm}{r} + I$ is more conservative when there is a surplus of mature timber over the normal growing stock, while if the mature volume is less than the normal volume $\frac{Vm-Vn}{x}$ becomes negative and the use of the modified form $Y = \frac{Vm}{r} + \frac{Vm-Vn}{x} + I$ will tend toward a more conservative figure. Whichever form is used, care should be taken to check the results by the area-volume method as illustrated here.

DISCUSSION

The formula introduced in this paper, $Y = \frac{Vm}{r} + I$, for the determination of the annual cut on a sustained basis in virgin American forests differs from the various European formulæ in that it is based upon the fundamentals in forest knowledge, namely, the mature timber volume and the actual mean annual increment of the immature stands.

Both these factors are absolutely necessary before the cut may be decided upon with any degree of certainty. If there is no young growth, the cut becomes equal to $\frac{Vm}{r}$ for the first rotation, after which there will need to be a revision and another figure set for the next period.

The formula in its modified form $(Y = \frac{Vm}{r} + I + \frac{Vm-Vn}{x})$ bears some resemblance to the Austrian (Heyer's) formula, this latter being written $Y = I + \frac{Vm-Vn}{x}$ and would undoubtedly apply to forests which have approached some degree of normality, such, for instance, as those illustrated in this discussion on page 623 where the mature timber volume is practically zero, and the annual cut would be mostly determined by the mean annual increment. The Austrian method, however, is not applicable to the virgin forests of this country because only the surplus stock (or deficit) is taken into consideration instead of the surplus and the total mature volume, the latter furnishing the cut for a considerable part of the first rotation.

The actual mean annual growth of the immature stands is determined from yield tables applicable to the region, and in the calculations the average growth for each age-class is taken at an age equal to the present age plus one-half the rotation. This is found to simplify the calculations and is sufficiently accurate for all practical purposes. A check of this method for normal forests in one case gave a difference of only 4 million feet out of a normal increment of 104 million feet, and on another area the difference amounted to a trifle over 2 million feet where the normal increment amounted to 73 million feet.

The method of determining the cut presented here has been developed in connection with even-aged forests which will be managed under a clear-cutting system, but the principle of the formula no doubt can be adapted to other forest types, such as the mixed hardwoods, the western yellow pine selection forests, and others where there is a large stock of mature and over-mature timber where the growth is at a standstill in addition to a certain amount of immature timber which is putting on a certain increment each year.

COMMENT

By E. E. Carter:

Mr. Hanzlik's interesting and timely paper seems to me incomplete. He does not discuss the question of how to handle the loss in volume which is occurring in many mature stands of Douglas fir. Taking his major illustration, the last of the mature timber would not be cut until the sixth decade from the present (1971 to 1980) and during this period of over fifty years it is quite possible that the stand per acre in the present mature Douglas fir stands would be reduced to some extent. It might or might not be possible to prevent any such loss by cutting, during the earlier decade, those stands which are the most overmature.

Another factor which must be considered in the practical application of Mr. Hanzlik's suggestion is that in many cases the major portion of the investment necessary in order to get operations started in a watershed is for transportation rather than for manufacture. In order to secure operations, the cut must be capable of carrying the depreciation (frequently on the basis of prospective obsolescence) of the manufacturing plant, and of the original investment in transportation. In practice this is apt to be a factor which at least counterbalances the opportunity for permanence of the main-line transportation. The need to depreciate the investment in plant and transportation combined may necessitate a larger cut during the first decade or two than can be permanently sustained, although without question the conservative basis advocated by Mr. Hanzlik is the more desirable. In view of the relatively early obsolescence of manufacturing plants, a reduction in the cut after the first two decades need not necessarily prevent the continuance of operations, provided the later cut is large enough to justify the maintenance of the main-line transportation and the depreciation of the new, modern, but smaller manufacturing plant. In short, the ideal of an increasing cut, or at least a stable cut, may, under some circumstances, have to be modified in order to secure a permanent transportation system, and it can often be modified somewhat without irreparable loss. It should not be so modified, however, unless absolutely necessary.

CAN MISTLETOE BE ERADICATED BY PRUNING?

By Walter J. Perry

Lumberman, U. S. Forest Service

Three years or so ago we got considerably "het up" about mistletoe (*Razoumofskya robusta*) eradication in yellow pine. It seemed that our marking policy in infested stands might result in practically a clean cutting of all merchantable sized timber without having any very appreciable effect on the eradication of the pest, for the reason that a great deal of unmerchantable material, heavily affected, was left standing and would quite certainly promptly infect any seedlings that might come in. This was true and is true.

What we wanted to know was whether it would be practicable to pick out likely trees on these areas as potential seed trees and actually rid them of mistletoe by pruning. I thought it could be done. To this end a great many were trimmed up, every branch which showed infection being lopped off close. Saplings with the parasite on the main stem were considered hopeless, as to clear them of the plant would effectually girdle the tree, and accordingly they were not used in the experiment. Some trees were selected in such isolated locations that it was supposed they could not possibly become reinfected from their closest neighbors. It was realized, of course, that the young trees might be already infected in places that had not as yet become noticeable. We wished to know to what extent this might be so. A recent examination, three years after the pruning, shows that practically every tree was in fact so infected, and has since the pruning developed mistletoe.

From the above it is evident that a single pruning will not rid the trees of the parasite, but that it probably could be done by a second pruning before seed were developed by the new plants. However, even this cannot perhaps be stated positively until it is known to what extent the plant extends its roots or mycelium from which new plants might sprout after the pruning of all visible portions. It is known that the living mycelium may exist for a great many years under the thick bark of trees and cover a quite large area, and that it will sometimes put forth where the heavy bark is removed as by an axe blaze. Sometimes it exists in the interstices between the ridges of heavy bark.

It remains to be seen whether young trees sufficiently isolated as not to be subject to reinfection from their neighbors can be rid of the mistletoe even by a second trimming. Also, the earliest age at which the new plants may bear their first seed crop must be determined, as in order to eliminate the mistletoe from the tree it would, of course, be necessary to do the second pruning previous to this time. In this experiment it was noted that some of the new plants bore seed in the third year.

In his study of mistletoe damage to conifers in the Northwest, Weir determined that the plant could not gain a foothold on wood more than three years old, and that the bulk of infection took place on the bark of one-year-old twigs. However, the plant has no trouble in reaching the outer twigs of its host by reason of its power of expelling its mucilaginous seeds with such force as to carry them ten or twelve feet in horizontal distance, and a single female plant may not only spread over a large part of the crown of the host tree but infect surrounding seedlings for some distance.

It requires one to three minutes' time to prune a sapling of a size that can be reached from the ground with a 32-inch hatchet, and going over the tree twice would about double this time. Four to six trees per acre would eventually reseed the area.

The indications are that mistletoe can be eradicated from individual young trees by pruning them and repeating the operation after two years. Unfortunately, however, this is not by any means all there is to it, as there are usually a great many specimens that cannot be saved, and which are too small and rough to have any commercial value. They will linger along for many years before the plant finally causes their death, and will continue to distribute mistletoe seed, if not to the pruned seed trees at least to seedlings coming in on the area. The result would be that the next generation of trees would be not quite but almost as heavily infected as the present one, with the exception of the original seed trees which could not easily become infected except by the agency of squirrels or birds distributing the seed to them.

Apparently the only way to actually rid an area of mistletoe is to do the whole job at once, by pruning selected trees as above, and then felling all other infected trees. Doubtless this would be entirely possible, but whether we could afford to practice such intensive forestry when our stumpage is only worth a dollar or two is an entirely different question.

THE FOREST FIRE HAZARD IN THE ADIRONDACK AND CATSKILL REGIONS

By Arthur S. Hopkins
Conservation Commission, State of New York

At the present time, when the question of what measures to adopt to insure the productivity of our forest lands is receiving such a large amount of consideration, any definite facts relating to the basic element of the fire risk are very timely and should be of great interest and value. Although the statements in this paper relate only to the Adirondack and Catskill regions of New York State, they indicate the results of the actual operation of fire protective measures and serve as an example of what may be accomplished in other regions. This study is simply an attempt to put into usable form the statistical information relating to forest fires which has been collected by the Conservation Commission since 1903. Prior to this date the statistics are so fragmentary and incomplete that no deductions of value can be drawn from them.

The area protected from fire by the Conservation Commission in the Adirondacks and Catskills embraces about 7,270,000 acres and covers all the forested area within these regions. Two-sevenths of the area is State land upon which no lumbering has been carried on but which is open to unrestricted recreational use. Upon a large part of the privately owned lands extensive lumbering operations, resulting in heavy slash have been general during the period under consideration. Fire losses for any single year do not furnish a true index of the average risk as they are subject to many influences which vary them tremendously from year to year. Therefore some method of grouping into periods had to be adopted. As the years of extreme fire hazard and severe loss have come at about 5-year intervals, 5-year periods have been adopted going back to 1903 from 1921, the first three being full periods, the last one (1903-1906) of 4 years only. By this grouping the bad fire years of 1903, 1908, 1913, and 1921 each fall into a separate group.

The top-lopping law, oil burning on the railroads during the summer months, and the present fire protective system of observers, rangers, and district rangers were placed into operation in 1909, but of course

did not function fully till some years later. Little had been done in public education regarding care with fire prior to this time.

The statistics relating to the number and sizes of the fires and the per cent of the protected area burned over have been combined by the periods outlined and are presented in tabular and graphic form.

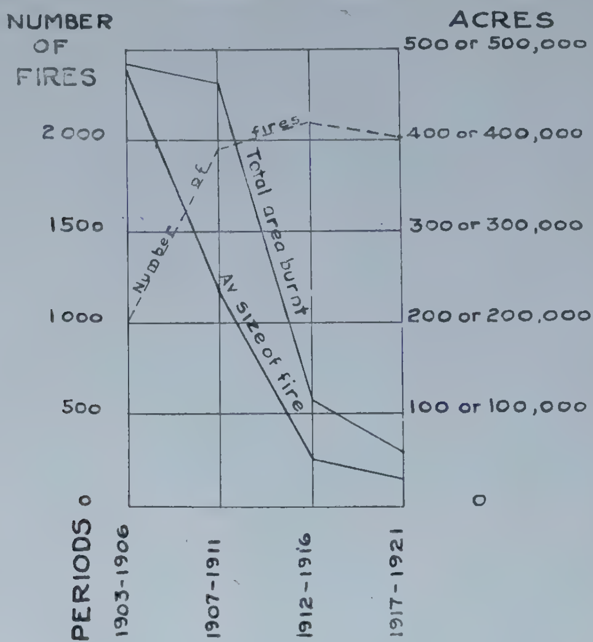

FIG. 1.

An examination of this table and the curves (figure 1) reveals much valuable and encouraging information which may be summarized as follows:

NUMBER OF FIRES

Since 1907 there has been no appreciable increase in the number of fires per period despite the fact that the number of persons using this area has increased steadily every year until today on account of good roads, with the general use of motor cars and the increased public interest in the great outdoors, the number of recreationists visiting these areas annually is a great many times that of 15 years ago. This indicates that while the public is becoming increasingly careful with the use of fire, there is still need of continued educational work. The

fact that since 1903 fishermen, hunters, campers, and smokers combined have been the reported cause of over 40 per cent of the total number of fires only emphasizes this need.

The increase in the number of fires for the period ending 1911 over the preceding one is accounted for by the fact that the first period covers only 4 years and also that during it fires of small area were not reported. Since that time all known fires have been reported however small.

AREA BURNED

The compilation shows in a striking way the result of the present fire protective system of observation stations, telephone lines, and rangers, of the use of oil on the railroads and of the operation of the top-lopping law. These measures were put into operation in 1909 and the great decrease in both the average size of the fires and the total area burned during the next subsequent period (1912-1916) must be directly attributed to them and the continued decrease during the next 5 years to their increased efficiency. Of course the results of top lopping are secondary to those of the fire-fighting system but have played an important part in reducing the duration of the fire hazard following lumbering and also the difficulty of fighting fires on lumbered areas. The area burned over during the last period is only 13 per cent of that burned from 1907 to 1911, and the average annual risk has been reduced from 1.2 per cent in the period 1907 to 1911 to 17/100 of 1 per cent in the 5 years ending in 1921. A combination of the figures for the average annual per cent of the protected area burned shows that the average annual risk from fire has been 55/100 of 1 per cent for the last 15 years, 23/100 of 1 per cent for the last 10 years, and 17/100 of 1 per cent for the last 5 years. It seems safe, therefore, to assume that the maximum average annual risk for the future will not exceed 15/100 of 1 per cent.

The reduction of the fire risk to this per cent has been accomplished by the Conservation Commission without cost to the individual owner. It means a maximum fire risk of 6 per cent on a 40-year rotation, which is not too great a risk to prevent reforestation or other forestry measures. The expenditure of a small amount by the owner of a particular forest area will further decrease this risk upon his land. And the further reduction of the risk over the entire Adirondacks and

Catskills will depend in a large degree upon the cooperation and efforts of the private owners of timberland and the general public. The State will do all in its power to further increase the efficiency of its system but the owner of woodlands cannot expect that the fire risk can be reduced to a minimum without some effort on his part.

TABLE 1.

Period	Number fires	Total area burned	Average per fire	Per cent of protected area burned	
				During period	Yearly average during period
		Acres	*Acres*	*Per cent*	*Per cent*
1903-1906	1,012	484,111	478	6.6	1.6
1907-1911	1,983	463,073	233	6.3	1.2
1912-1916	2,088	110,822	53	1.5	0.3
1917-1921	2,002	62,129	31	0.85	0.17

REVIEWS

Shade and Ornamental Trees of California. By Merritt B. Pratt, State Forester, California State Board of Forestry, 1922 (?).

Fittingly, this welcome volume is dedicated to the memory of the late G. Morris Homans, State Forester of California from 1910 to 1921. The preface is by Prof. Willis Linn Jepson of the University of California. The book contains 132 pages of text and index and 137 full-page half-tone illustrations, showing in most cases full-height views of the trees.

The book is divided into two parts: Part I is descriptive of conifers and broadleafed trees, and Part II contains tree lists for different regions of California.

No attempt is made in Part I, "Conifers and Broadleaf Trees," to give all of the distinguishing characteristics of the various generic groups and species presented, only the salient botanical characters being pointed out. The illustrations are so excellent that in most cases the reader can easily identify the different trees.

Lovers of trees will be greatly interested in the historical and other information brought together under each group and species of trees. The practical viewpoint of the trained forester is evident throughout in the decidedly valuable and useful statements made regarding the sizes attained, habits, range, site, and the soil and climatic requirements of the different trees.

The wonderful possibilities of California conditions for the cultivation of native and exotic trees become evident in a survey of the wide range of the trees found growing there from temperate and tropical parts of the world. Thirty-three native California trees are represented in public parks and grounds; while 19 different species are from various parts of the United States outside of California, together with 104 exotic trees are of European, Asiatic, and South American origin. Altogether, something over 150 different forms of North American and foreign trees are represented in the cities and towns of the great valley and coast regions of the State.

It is interesting to note in passing how well adapted some of our native eastern trees are to the soil and climatic conditions of Calfornia.

Conspicuous among these are Magnolia grandiflora, Ulmus americana, Liriodendron tulipifera, and Taxodium distichum. The magnolia grows luxuriantly and flowers freely, as does also the tulip tree. Strangely enough, however, flowers of the latter species are only about one-half the size of those produced by eastern-grown trees.

Part II of the book, "Tree Lists for Different Regions of California," is of particular interest to those desiring to know the sorts of trees that are suitable to plant along highways, in lawns and for windbreaks. The State is divided into four regions—Sacramento and San Joaquin Valleys, Coastal, Foothills, and southern California. For each of these regions the author gives lists of trees suitable for the above-named purposes. Most of the trees recommended have been thoroughly tried out in the various regions. To these lists are also added two very important lists of trees, namely, those that are strongly resistant, and fairly resistant to alkaline soils.

The author is to be congratulated for having produced a book that meets a distinct need. G. B. S.

Research Methods in the Study of Forest Environment. By Carlos G. Bates, Silviculturist in Charge of the Freemont Forest Experiment Station, and Raphael Zon, Forest Economist. Contribution from the U. S. Forest Service, Agriculture Department Bulletin 1059, pp. 209. 1922.

It is with considerable hesitation that the reviewer undertakes a critical review of this voluminous bulletin which deals with methods of investigation in a subject so complex and so filled with uncertainties and speculation. Ecological studies have received a fair measure of attention on the part of American botanists and foresters in recent years as attested in the voluminous publications by Clements, Livingston, Shreve, Pearson, Weaver, and others. All of these investigators in their attempt to correlate site factors with vegetation have discussed methods and instrumentation to a more or less extent. The entire subject, however, is in such a condition of flux, that methods are often no longer established than they are abandoned for others. In many cases the data assembled at large cost in time and money are no longer considered trustworthy and new methods are undertaken which no doubt will soon give place to others. Thus the advance in the knowledge of the soil as set forth in Russell's recent volume shows the uselessness

of extensive soil studies made in the past where little or no consideration was given to soil colloids and to the flora and fauna of the soil.

Recently Wiegner states that the incomplete state of our knowledge of the effects of humus makes this an almost unknown field in a scientific sense. Even the most approved present methods of soil investigation in relation to plant growth can be nothing more than stepping stones to better methods to be worked out in the future.

Methods for the investigation of solar radiation in its relation to plant growth, particularly methods useful in silvical studies, are wholly inadequate.

If we take the whole list of site factors which make up a forest environment, it is surprising how little has as yet been accomplished in establishing sound methods for measuring each of these factors in terms of their duration and intensity of action and in correlating each and the complex of all with vegetations which result from their action.

Foresters whose interests lie in the field of silviculture should know the best methods for the study of forest environment. A knowledge of the relation of the site factors to forest growth is fundamental in a silviculturist's training.

For a score or more of years the authors of the bulletin under review have been actively engaged in testing out methods and instruments, and the silviculturists of the country welcome this comprehensive presentation of research methods in the forest environment. The subject, however, is in such a rapid state of evolution, the bulletin can be considered little more than the authors' judgment of the more important problems that confront the student in forest environment and the best methods by means of instrumentation whereby they are most likely to be solved. The bulletin of 209 closely written pages, supplemented by graphs, numerous tables, appendices, and a bibliography, will become a reference books for students of plant ecology as well as foresters interested in the foundations of silviculture. The volume fills a place in American forest literature that has not heretofore been occupied.

In their introduction, the authors state that the development of forestry is based on fundamental knowledge of the natural sciences and that the present day forester is keenly alive to the need for help from every possible source of scientific information. Silviculture is the heart of forestry and an understanding of this subject necessitates a background of training in a wide range of underlying sciences. The silvi-

culturist must, in his investigations, cover so wide a field, and is so often governed by some practical economic problem, he finds little opportunity, and often lacks necessary training in the underlying sciences, to do effective work in the study of the diverse problems of forest environment. The authors have done well in placing emphasis on the need of foresters cooperating with scientists in the diverse fields of natural science, in solving many of the fundamental problems which now confront them.

Of all the branches of American forestry, silviculture, although the most important, has lagged in the background so far as American forest research is concerned. Although applied silviculture, if removed from empirical methods of practice and placed on a scientific basis, must rest on a comprehensive knowledge of site factors in their relation to forest vegetation, scarcely a beginning has been made as yet by foresters in this country in solving the underlying problems.

The authors fully appreciate that a handbook presenting cut and dried methods by which research is to be conducted is repugnant to the true investigator. They appreciate that he must be able on occasion to devise new tools and apparatus for new and special purposes. They therefore set forth that the aim of the bulletin *is to clarify the problems so that the investigator may choose for himself the method of approach.* They do not recommend, but on the other hand they enumerate methods and equipment describing their past accomplishments. By erecting a foundation for the future upon the experiences of the past, they hope to save those undertaking research in this field much needless and fruitless effort. It is extremely difficult for the reviewer to state how well they have succeeded, due to the fact that the methods of today, erected on the experience of the past, are subject to such rapid change.

The bulletin is concerned wholly with ecological forest studies. These studies aim to express relations between the site factors and the vegetation. The statements are made that *the control of environment is the cornerstone of the practice of forestry and that the practice of forestry is, in a very large degree, the application of ecology.* With these statements the reviewer is in full accord. Ecological forest studies deal with a great diversity of problems which involve the determination of the effect of diverse site factors on reproductions, initiation, growth, and physiological functions. These problems are illustrated in studies

on seed production and the characteristics of seeds as related to origin; in studies on the correlation between the composition, succession and growth of forest vegetation on the one hand, and the condition of the environment on the other; in natural regeneration and methods of cuttings for definite silvicultural purposes; in forestation and in studies on the requirements of trees for shade and water and their competition for light and moisture. These various studies involve the measurement of the intensity and duration of the aerial and subterranean factors and the functioning of the vegetation in response to them.

Emphasis is placed on *the importance of the sample plot method in ecological forest studies and the need of permanent organization in forest investigations.* Forest studies for the most part require observation extending over a more or less extended period of time; hence, the necessity of forest experiment stations which insure the completion of long time experiments.

In this connection the reviewer desires to emphasize the great need of organized forest research in the higher educational institutions of this country. Agricultural research is almost entirely centered in our educational institutions, and forest research will not attain the importance that it merits until it becomes an essential part of the established work of our colleges and universities where forestry is taught.

Following an introduction of ten pages, the book is largely given to a comprehensive discussion of environmental conditions affecting forest vegetation and methods for measuring them.

Following a brief discussion of the climatic characteristics of locality and periods of growth and rest in which emphasis is placed upon the importance of utilizing weather bureau data, some 150 pages are given to special observations *on climate and soil of locality.* This subject is introduced by a discussion on the location of instruments in the study of instruments in studying environmental factors affecting reproduction. Special importance, and justly so, is placed upon the location of instruments in studying invironmental factors affecting reproduction, as the investigator is concerned with the immediate conditions of the surface soil and the aerial conditions just above.

Air temperatures, soil temperatures, solar radiation, precipitation, soil moisture and soil qualities, atmospheric humidity, wind movement, and evaporation are taken up for discussion in successive order and each is described from the standpoint of problems believed by the

authors to be most important in their relation to forestry. The forester engaged in research on forest environment will find here innumerable suggestions regarding instruments and their use and suitability for special investigations. He will also find standard methods that have proved most useful in recording the data as taken in instrumentation.

Some criticisms no doubt will be made due to the unequal treatment afforded the above factors and to the omission of certain other factors which influence forest vegetation. Exact methods and instruments for measuring air and soil temperatures are well known. They are more readily measured than almost any other conditions of forest environment. On the other hand, although the influence of solar radiation has never been under-estimated by foresters, the problems involved in its measurement in terms useful in the study of forest environment are still unsolved and the authors are unable to offer much of constructive value in this direction. They offer an experimental method for determining the minimum light requirements for trees by growing them in a specially constructed solarum where all factors are under control. They are of the opinion that the *past investigations of light in connection with forestry are practically, without exception, obsolete and of no assistance in looking into the problems of the future.*

Fricke, Burns, and others have shown that the phenomenon commonly called by foresters "suppression," and which has been credited to insufficient light, is no doubt in many instances caused by root competition for moisture and nutrients. Although the authors emphasize the inadequacy of photometric methods in solving the problems centered in variation in the minimum light requirements of trees, it is believed by the reviewer that these methods should not be entirely abandoned, particularly where investigations are being made on the comparison of light in the open at a given time with light which reaches the forest floor. Although the limited range of wave lengths which affect silver salts and cause a darkening are different from the almost infinite variety of wave lengths that are absorbed by the tree and affect it in one way or another, the photometric method merits further consideration. It is admitted by the authors that it serves fairly well to measure the density of the canopy. Although photometric methods cannot be used for the measurement of solar energy in the form of light in absolute terms, or for comparing light in different localities at which exposures are made at different times, the reviewer knows of

no other means which serves so well in making comparisons between light in the open and under canopy.

Under the discussion of soil moisture and soil qualities, great emphasis is placed on the importance of direct measurement of soil moisture. It is shown, however, that before the measurement of soil moisture has much meaning, there are a large number of related problems which must be solved. The subject of soil moisture is discussed under the following heads: total moisture, non-available moisture, available moisture, the co-efficient of availability and other conditions not indicated by the osmotic pressure of the soil solution at any time. Much attention is given to the discussion of the wilting co-efficient and the moisture equivalent as defined by Briggs and Shantz. Numerous tables and graphs show the wilting co-efficient of various species of conifers in different soils, the relation of wilting co-efficient to capillary moisture, and the relative amounts of water held in different soils against various forces.

In the discussion of the co-efficient of availability much is made of the density of the juices of the plants growing in a given soil as correlated with osmotic pressures, due no doubt to one of the author's special investigations on osmotic pressure a disproportionate amount of space is given to it. Taking into consideration the great importance now attributed to the colloidal properties of the soil and the micro-organic properties of the soil, it would seem that a manual of research methods in the study of forest environment should not so completely ignore them.

Much space, and justly so, is given to the importance of the desiccating power or "evaporation stress" of the atmosphere. Not only the objects and nature of evaporation measurements are fully set forth, but also instrumental methods. Under the latter, the operation of the Forest Service evaporimeter is described and its practical qualities emphasized. The reviewer is somewhat skeptical as to how closely evaporation from it resembles loss of water from the leaf.

Exclusive of the appendices, the work closes with some 6 or 7 pages on Phenology and phenological data. The statement is made that much good effort has been wasted on phenological observations due to lack of correlation between the phenomenon of growth and other conditions except time. The question is raised, how can phenological observations on the plant be made worth while? The authors believe that

in the past the plant community has perhaps been used too much as an index of reactions, that this method is too gross, and has lead to a great many erroneous conclusions. They believe that more is to be learned as to the requirements of different species by the close observation of individuals; by the permanent marking of individuals that their condition may be made a matter of daily observation. While the importance of external field observation on the individual is fully set forth, emphasis is also placed on the study of the more fundamental reactions in the plant itself which lead up to growth.

The appendices cover more than 50 pages of closely written matter. The insertion of the 20 or more pages of vapor pressure tables—Wagon Wheel Gap, Colorado—as Appendix A, has little bearing on the remainder of the work. Taking the bulletin as a whole, it makes available in the bibliography a very complete list of references to the literature of forest ecology that deals with methodology, and is a most important publication as an aid to forest investigators in the general field of forest ecology.

J. W. T.

Om Beräkningen av Konstanterna i Höyers Stamkurve-ekvation, Nils L. Söderlund. Skogsvårdsföreningens Tidskrift. Nov.-Dec., 1918. Pp. 636-640.

The determination of the constants in Höyers' general equation of tree form is a difficult and time-consuming procedure if the method outlined in Chapman's "Forest Mensuration," page 210, is followed. For the benefit of those who are investigating the possibility of using Tor Jonson's methods and tables on this continent or who have cause to use these constants in the calculation of normal tree form, the following practice is recommended:

Höyers' formula for tree form is:

$$\frac{d}{D} = C \log \frac{c+1}{c}$$

Where D = d.b.h., d = the desired normal diameter lying at a distance l, a certain per cent of the height of the tree from breast height to the tip. C and c are constants varying with the form class of the tree.

If the absolute form class 0.70 is taken, the following relations hold true:

$$0.70 = C \log \frac{c + 50}{c}$$

$$1 = C \log \frac{c + 100}{c}$$

From these equations both C and c can be calculated, but it is far easier to divide the first equation above by the second, so securing an equation where c is the unknown and can be arrived at through successive approximations (see Chapman, page 210). It is much more convenient to eliminate c and solve for C. The variation of C is much less than that for c in the form classes used in practice. On common cross section paper a small number of values of C can be plotted in relation to the form class, in this manner eliminating a certain amount of work.

The following method is used to eliminate *c* and solve for the value of C:

Let x = the absolute form class;

Then, as above,

$$x = C \log \frac{c + 50}{c}$$

$$1 = C \log \frac{c + 100}{c}$$

Or,

$$\frac{x}{C} = \log \quad 1 + \frac{50}{c}, \text{ and } \quad 10^{\frac{x}{C}} = 1 + \frac{50}{c}$$

$$=$$

$$\frac{1}{C} = \log \quad 1 + \frac{100}{c}, \text{ and } \quad 10^{\frac{1}{C}} = 1 + \frac{100}{c}$$

From which

$$10^{\frac{1}{C}} = 2 \cdot 10^{\frac{x}{C}} - 1$$

This equation gives a relationship between x and C, i.e., between the form class x and the constant C, and by this means C can be calculated. In the solution a certain form class x answering to a predetermined value of C is found. Take, for example C = 1;

Then $10^1 = 2 \cdot 10^x - 1$

$$10^x = \frac{11}{2} \text{ or } x = \log \frac{11}{2} = 0.740$$

The form class is then 0.74. In the same way other values of x can be ascertained. Plotting, to a comparatively large scale, a sufficient number of the derived values of x (as ordinates) on the chosen values of C (as abscissæ) will give a curve from which the value C for any form class may be read off.

When C is known for a certain form class, c naturally is found by placing the value of C in the stem curve equation, for form class 0.70 C is equal to 1.280;

Then $0.70 = 1.280 \log \frac{c + 50}{c}$, $c = 19.78$

Figures arrived at in the above manner serve for Norway spruce; for Scotch pine, due to poorer form, the Höyer equation has been changed somewhat by Professor Tor Jonson through the introduction of the so-called "biologic constant."

The equation used is

$$\frac{d}{D} = C \log \frac{c + 1 - 2.5}{c}$$

Then

$$x = C \log \frac{c + 50 - 2.5}{c}$$

$$1 = C \log \frac{c + 100 - 2.5}{c}$$

or

$$10^{\frac{x}{c}} = 1 + \frac{47.5}{c} \qquad 10^{\frac{1}{c}} = 1 + \frac{97.5}{c}$$

$$10^{\frac{1}{c}} = 2.0526 \times 10 \; 10^{\frac{x}{c}} - 1.0526$$

B. E. C.

Storage of Coniferous Tree Seed. By C. R. Tillotson, Journal of Agricultural Research, Volume XXII, No. 9, Nov., 1921.

In all countries where coniferous seed is collected in quantity for direct seeding or for use in forest nurseries, the decrease in viability and germination energy of the seed during storage is of vast economic importance. Experience both in this country and abroad conclusively shows that coniferous seed kept from one year to another under artificial methods of seed-house storage, gradually decreases in viability or more or less rapidly becomes worthless. Failures in direct seeding and in nursery practice are still traceable to this cause. Nurserymen

are still sowing worthless seed and hundreds of pounds of non-viable seed are directly seeded each year with invariable failures.

Only last year a lumber company directly seeded a large area with long leaf pine seed carried over from the previous year in grain sacks stored in an office. The seed, although with high germination values when collected, was non-viable when sown and the labor went for naught. In almost every forest nursery some of the seed beds show few or no seedlings due to the use of non-viable seed or seed with low germination values.

American foresters and nurserymen must more fully appreciate the importance of knowing the viability of tree seed before accepting it for use in forest nurseries or for direct seeding. It is far better to discard poor seed altogether if better can be obtained. If it cannot, germination values must be known, as they provide the only index to the amount of seed necessary to use per unit of area in order to escape failure. To a far greater extent than justifiable from economic considerations, the users of tree seed are inclined to use the seed at hand without a history of its origin and age, and trust to luck to get a stand.

Due to the deterioration or loss in viability of tree seed with age, and the necessity of collecting during years of heavy seedage for use in years of lean crops, European foresters have for many years carried on extensive studies to determine the best method of seed storage for their own species. Cieslar, Haack, Zederbauer, Rafn, and others have shown the effects of temperature and humidity on the retention of viability during long storage, and the superiority of sealed retainers over other kinds for the storage of such species as Scotch pine and Norway spruce.

Due to the fact that the seeds of the various species exhibit wide variations in keeping qualities under identical storage, and the results obtained from the studies of European species cannot safely be translated for American species, the United States Forest Service planned an extensive series of experiments on seed storage which were undertaken in March, 1909. Seeds of the previous autumn's collecting of Engelman spruce, western white pine, lodgepole pine, western yellow pine, white pine, and Douglas fir were assembled at Washington and after thorough air drying were placed in five different kinds of containers, and sets of each were sent to thirteen widely different localities in the United States for storage. Five sets were for storage at

ordinary indoor temperature with artificial heating in winter, five at fluctuating temperatures as in an unheated garret, and five at lower and more uniform temperatures as prevail in an unheated cellar.

In January, 1910, 1911, 1912 and 1914 samples of each of the six species in each of the containers stored under the three different conditions were returned to Washington for germination tests. Some of the seeds stored in air-tight containers, although opened at the end of five years, were again sealed and carried over until 1919, or for a period of ten years.

The research as originally planned was continued from year to year by a number of investigators, unfortunately no one being identified with it for the full period of the investigation. The shifting of personnel in a study of this nature, which brings it under the direction of several men at different stages of its progress, is most unfortunate and the results are not as complete and conclusive in all instances as should be expected. It is scarcely conceivable that an extensive series of experiments of this nature, planned to extend over a series of years and having for their purpose the determination of loss in germination values through storage under different conditions, should be undertaken without knowing the germination values of the fresh seed. Without knowing the viability of the fresh seed, the experiment, in the reviewer's opinion, loses half its value.

Mr. Tillotson, although evidently not responsible for the initiation or execution of the investigation over its entire period, compiled the data in a well arranged series of tables, has pointed out the difficulties encountered in the progress of the work in an attempt to deal with too many variables, and has indicated failures in the progress of the study that make the analysis of the results less satisfactory than were the project carried to completion and the results prepared for publication by the one who planned the investigation.

The article, of some thirty closely written pages, begins with a brief review of European investigations by Ceaslar, Haack, and others, on the problems centering around seed storage of European coniferous species. An excellent summary is given of the results of these investigators. The American investigations, initiated in 1909, are discussed under the following heads: (*a*) factors affecting experiments, (*b*) points of storage, (*c*) conditions of storage, (*d*) period covered by study, (*e*) seed testing operations, (*f*) conclusions, (*g*) what the

study shows, (*h*) effective container, (*i*) effective of temperature, (*j*) effective of geographical location, (*k*) results of storage at the end of ten years.

Space does not permit a detailed account of the results obtained in the analyses of the mass of data which deal with so many variables. It is clearly brought out, however, that for the six species studied, storage in air-tight receptacles is superior to storage in any of the other receptacles used. The average germination for the five-year period of the seed stored in sealed bottles over that stored in the paraffined paper sack, the next best retainer used, was 22 per cent. It is also brought out that thoroughly air dried seed in sealed retainers is little if at all affected by differences in temperature and humidity of the outside air or the geographical location of the storage point. The germination of the seeds stored in unsealed retainers, however, is seriously affected.

After air-tight storage, the efficiency of the retainers used is in the following sequence: paper bag paraffined, paper bag, and oiled cloth bag. The use, however, of any of these non-air-tight retainers results in the rapid deterioration of the seed, particularly after one or two years of storage, the seeds of some of the species being rendered practically worthless. The seeds stored in non-air-tight retainers kept much better under ordinary heated room conditions where there is lower relative humidity than in basements or cellars, or in unheated buildings. Localities at high elevations and elsewhere where the relative humidity is low, proved much better points for storage in non-air-tight retainers than along the coast and at other points where the relative humidity is high. There appeared to be great variation in the six species in respect to sustained viability under all methods of storage used, the pines retaining their viability much better than the spruce and fir.

Some of the seeds of all the six species stored in sealed retainers were kept in storage for ten years. At the end of this period germination tests showed that three of the species, namely, Engelman spruce, Douglas fir and white pine were unviable, while the remaining three species had a percentage of viable seed ranging from 22 per cent for western yellow pine, 9 per cent for lodgepole pine, and 6.5 per cent for western white pine. The results of this part of the experiment, however, is of little value, as the receptacles were opened at the end

of the five-year period, and after the removal of part of the seed, resealed until the end of the ten-year period.

This extended investigation on American coniferous seed, in the main, reinforces conclusions previously arrived at from studies made abroad on European species.

It is hoped that the U. S. Forest Service will continue studies on germination, but possibly planned on a less extensive scale with less variables to be considered and supported by laboratory methods for determining the psysiological and chemical changes which the seed undergo during storage. Studies should be undertaken on the storage of the seed of important hardwoods and particularly the less viable of the coniferous species, such as hemlock and the true firs.

Although the results of this investigation are of much importance in re-emphasizing the necessity for the use of air tight retainers in storage, if the study had been better planned and more systematically executed, thus eliminating such slips as failure to make germination tests on the fresh seed, opening the retainers at the end of a five-year period where seeds were stored for ten years, and the undoubted variability of the conditions of storage at each of the thirteen points, thus making comparison of doubtful value, much more would have resulted from the investigation. Although the general conclusions are not in all cases supported by the results of each individual test, due likely to the uncertainties in the many variable factors involved, the average results can be safely taken as a criterion of what may be expected of the species studied, under the methods and conditions of storage employed.

J. W. T.

Handbook of Field and Office Problems in Forest Mensuration. By Hugo Winkenwerder and Elias T. Clark. Second Edition. John Wiley & Sons, New York.

The first edition of this book appeared in 1915, having been prepared as an aid to laboratory instruction in forest mensuration at the University of Washington. This was revised by changes and additions, that it might be applicable in all sections of the country, and appears as the second edition. The authors state, in the preface, that no attempt has been made to present a complete series of problems for the entire field of forest mensuration, but, as the first object to present a series of carefully selected, practical type exercises to supplement recitations

and text book work; second, to eliminate all undue duplication in clerical work in order to avoid obscuring the fundamental objects of the exercise, and third to secure a thorough correlation of the individual fundamental problems in forest mensuration, and an arrangement to show their relation to the larger problems which are dependent upon a combination of the fundamentals. In the early exercises the fundamental problems are kept wholly distinct from each other and each treated in detail. In the exercises that follow, these fundamental problems have been combined with the more extensive ones to co-ordinate them, and emphasize their special relationships.

The table of contents shows the book to be divided into two parts; first, a series of eleven sections of problems and exercises, covering 83 pages, and second an appendix of 50 pages of references, data, tables, and mensuration forms. There are in all 40 distinct exercises, 16 of these being field exercises, 22 being office problems, and two being arranged for both field and office work. Each field exercise is started with an explanation of its purpose. The directions that follow give the details of "party," of the "equipment required," and the "method of procedure" for carrying on the work. In the office problems the directions show the data required and refer to this in the appendix. The method of procedure then follows. Pertinent references follow most exercises.

Section I.—"Preliminary Measurements" includes seven exercises, five of them being field exercises devoted to pacing, the determination of heights and diameters of standing trees, and the collection of data for volume and growth studies. The two office problems deal with the construction of dendrometers and hypsometers.

Section II.—"Use of Graphic Methods" gives directions for plotting and drawing curves on co-ordinate paper.

Section III.—"Log Rules" includes three office exercises in the construction, graphic comparison, and extension of log rules.

Section IV.—"Preliminary Calculations" also has three office problems dealing with the determination of the merchantable contents in board feet of felled trees, the total cubic contents of felled trees and the merchantable contents of trees in standards. There is also one field exercise for securing the contents of standing trees by rule of thumb methods.

Section V.—"The Construction of Volume Tables" gives five office exercises in this connection. In this section are instructions for con-

structing volume tables based on d.b.h. alone, on d.b.h. and total height, and by the frustum form factor method. The construction of taper tables, and tables of stem form factors is also explained here.

Section VI.—"Scaling" deals fully with methods of scaling logs in the field. Special attention is given to defect allowance.

Section VII.—"Determination of the Contents of Stands." In the words of the authors, "this has been outlined especially with respect to Pacific Coast Timber; however, very slight modifications will make it available for use in any section of the country." Three exercses are given—first a field problem in estimating the contents of a small tract of timber by different methods. Each of the other problems give instructions for both field and office work in crusing with and without the aid of volume tables.

Section VIII.—"General Growth Studies" includes one field exercise on the determination of the total ages of trees, and seven office problems covering growth in volume, height, and diameter with respect to individual trees, evenaged stands, and unevenaged stands.

Section IX.—"Sample Plot Studies" has three field exercises outlined. The first is one for securing the contents of a plot by, the mean sample tree method, by the arbitrary group method, and by the volume curve method. The second deals with the determination of the rate of growth in sample plots by making stem analysis of mean sample trees. The third exercise concerns itself with the determination of growth in even aged stands, the data being secured from a number of plots of different ages, and the results plotted and curved. This problem could have been incorporated with problem 39, "The construction of yield tables for even-aged stands by the band method." Yet as a fundamental problem it well deserves a place for its own. Too many problems in studying growth and yield can not be given, for invariably this phase of forest mensuration is the most difficult for the student to grasp.

Section X.—"Studies in Growth Percent" includes three field exercises on the use and application of both Pressler's and Schneider's well known formulae. In each exercise the data are secured from a one-fourth acre plot. It would have seemed advisable if one exercise had been included where the growth data could have been secured from trees of all species and ages, over a considerable area, worked up by curves and figures, and the increment percents secured from trees of

all sizes and species. These percents could then be applied to a stock table resulting in the volume growth over the entire area.

Section XI.—"Yield Table Studies." Two exercises are given. First an office problem in constructing yield tables by both the band method and the site factor method. Happily nothing is said regarding yield tables for mixed uneven aged stands. The last problem deals with the use of yield tables in the field.

An appendix of 50 pages follows. In this is a bibliography confined entirely to American works and periodicals; also tables of the more common units of land measurement, mensuration forms for use with the field exercises, and a large number of the useful and necessary tables which must be included in such a book. It concludes with several pages of data to be used in connection with the office problems.

In the opinion of the reviewer, a few illustrative diagrams and graphs could have been included to advantage. These would help particularly in Section II, and in some of the exercises dealing with volume tables, growth studies and yield tables. A table of natural tangents would also be of value.

One familiar with the subject of forest mensuration will find nothing new in this book. Nevertheless the arrangement of the material is so carefully worked out and so well presented that it will be an excellent aid to both student and teacher in this field. With any of the several excellent text books covering forest mensuration now available, this "Laboratory Manual" can be used and co-ordinated with excellent effect. Bound in limp cover, 5 by 8 inches in size, it is particularly well adapted for carrying into the field. The authors are to be congratulated in furnishing us with such a handbook. C. H. G.

Impressions of European Forestry. By Ralph S. Hosmer, M. F., Cornell University, Ithaca, N. Y. Pp. 80. Price, $1.00. To be obtained from the author.

This is a reprint of a series of letters appearing in the *Lumber World Review,* written during a visit to the various European countries. It gives account of conditions of forestry in Great Britain, the three Scandinavian States, parts of German forests, France and Switzerland, one letter being devoted to a discussion of the various forest schools. The author looks at things with American eyes with the idea of making his experiences useful in U. S. practice. The neat, copiously and well

illustrated booklet is especially recommended for laying out a program for those who contemplate similar visits. The author has succeeded in producing a useful as well as readable account of conditions in the countries visited.

B. E. F.

Code for the Collection and Tabulation of Statistical Data. By S. H. Howard, B.A., Imperial Silviculturalist, British Indian Forest Service.

"This note, which gives the outlines of the system of collecting and tabulating statistical data, incorporates the various methods advocated by the Silvicultural Conference held at Dehra Dun in 1918 and any actual rules given, e. g., rules for permanent sample plots, are those advocated and approved by these two bodies."

It is interesting to note in the title the recognition given to mensuration as a branch of statistics rather than a mathematical science. It is believed that more consideration should be given to this fact in this country and the more advanced statistical methods applied in forestry.

The publication gives in detail the procedure to be followed, both in the field and office, in the measurement of permanent sample plots, temporary sample plots, stem analysis, stump analysis, measurement of volumes and form factors of typical trees, bark and heartwood measurements, the collection of data to express the relation between lumber in the tree and converted outturn, and data concerning the existing growing stock per acre. The text is supplemented by appendices, under separate cover, giving sample-plot forms and actual examples of the methods prescribed. These include maps, tables, growth and volume curves, etc.

The methods are essentially those of European practice, reference being made to Schlich Volume III, and in addition to procedure to be employed with trees lacking growth rings.

It is also of interest that the use of calipers is prescribed to the exclusion of tape measurements.

The standardizing of the methods of collecting and tabulating data in this way is an excellent practice and is worthy of the attention of not only those interested in this phase of forestry but foresters in general. This procedure permits of ready comparison and combination of data secured at different dates, the advantages of which are only fully realized by those who have attempted the correlation of data collected by different methods.

R. M. B.

PERIODICAL LITERATURE

The Continuous Forest—A Review of Certain Articles Appearing in German Forestry Journals, 1920 to 1922

By Ralph C. Hawley

An article by Möller published in January, 1920, describes the management over a 29-year period of a Scotch pine forest under a new method of treatment designated by the author of "Dauerwaldwirtschaft." A brief, concise translation of this term into English is difficult; possibly "management which maintains the continuity of the forest or maintains a continuous forest" is as close as anything. The idea involved can best be brought out by a review of Möller's article.

The forest described, containing approximately 1,600 acres of Scotch pine stands of varying ages, is located at Bärenthoren some distance southwest of Berlin, Germany, on sand soils of the fourth quality for pine. Rainfall is approximately 22 inches per annum.

"Dauerwaldwirtschaft" had been practiced in the forest for 29 years (from 1884-1913), at the time the data for the article were gathered.

Records of the forest are available at least as far back as 1833. In that year the stands were reported to be in poor condition due to raking of litter. From that date on until 1884 reports at intervals mention unfavorable conditions existing as relates to soil, age class distribution and character and growth of the stand.

Evidently when the present management was initiated, the forest was in a run down condition and showed the effect of mismanagement.

Möller divides methods of management into two groups.

(1) The "Dauerwald" methods.

(2) The clear cutting methods.

Wagner's "Blendersaumbetriebe," known in this country as "Border Cutting," is of the first group, but is suited only to regions with rainfall of 28 inches or more. Pine in Germany is grown mainly where the rainfall is between 20 to 24 inches and cannot be treated by Wagner's method. The "Dauerwald" method has been proved practicable for pine forests on poor sand soils with low rainfall.

What are the characteristics of this method as described by Möller? Its principles are broadly stated as—

(*a*) Maintenance of forest conditions. Includes uninterrupted tending of the soil and of the stand.

(*b*) Use of natural regeneration.

(*c*) Annual felling of selected individual trees. The single tree rather than the stand is the unit.

(*d*) Securing the highest possible growth per cent on the biggest and most valuable growing stock.

The features which appear as noteworthy in the 29-year application of these principles on the forest described are:

1. Entire absence of clear cuttings. None of the area is ever cleared of forest. Möller says that a clear cutting method keeps one-fourth of the area unproductive so far as timber production is concerned.

2. The entire forest is gone over annually and carefully thinned. This includes thinning in overstocked, stagnating young stands where the unmerchantable product is left on the ground. In young and middle-aged stands no gaps should be created large enough to make bordering trees more branchy or increase the danger of snowbreak. Overtopped trees though still able to live are cut. The greatest attention is paid to developing the crowns of the individual trees with the object of having the crown occupy about one-third of the total height. In the older stands the annual thinnings become somewhat heavier anad break the crown cover appreciably.

3. The success of the method is attributable in large measure to the technical ability of the owner, a trained forester, who has personally done a large share of the marking for the annual thinnings.

4. All branches and the thinnings in young stands remain on the ground, thus building up the litter.

5. Removal of the litter, previous to 1884 a common practice, has been prohibited.

6. In the older stands pine reproduction is desired and encouraged. It now comes in freely as soon as the crown is broken. During the first ten years of the experiment very little reproduction started, but with improved soil conditions it finally appeared in all of the oldest stands. The reproduction is approximately even-aged (within a 10-year range) under even-aged old stands of 60 to 93 years of age.

Only in the worst spots, most abused in the past, is it necessary to plant. Beech is used for this purpose.

7. A fixed rotation age is not considered. Each tree is held as long

as possible, then removed. This is done because the greatest growth per cent in timber is secured from the large trees. As yet the method has not been applied for a long enough period to judge at about what age most of the old timber in any given stand will have been harvested.

Striking results have already been attained by the use of the "Dauerwald" method over a 29-year period. The cut of timber which in 1872 was 21 cubic feet per acre had risen to 47 cubic feet average per year (the accuracy of these figures of Möller's has been questioned by several other writers) for the period 1884 to 1913, during which the "Dauerwald" method was applied. In addition to this annual cut of 47 cubic feet of timber the inventories at the beginning and end of the period showed an addition to growing stock equivalent to an annual growth of 43 cubic feet per acre in excess of the cut.

The quality of the site as gauged by yield tables has been raised from IV to II during the period. Cessation of litter removal together with building up of the soil cover and maintenance of forest cover over the entire area is considered the cause for this improvement in site quality.

Möller recognizes as drawbacks in applying "Dauerwaldwirtschaft" the difficulty of control and the lack of adequately trained personnel.

This article by Möller [1] led to the publication in the European forestry journals of numerous other articles by various foresters. The discussion has continued down to the present time. To show the sentiment a number of articles are reviewed.

Trebeljahr [2] analyzes the operations of the "Dauerwaldwirtschaft" for the purpose of learning; first, in what "Dauerwaldwirtschaft" consists; and second, what caused the remarkable increase in growth from 1884 to 1913.

The essential things done in the forest he finds were:

1. Preservation of forest litter.

2. Accumulation of tops, unmerchantable trees, etc.; to increase soil fertility.

3. Planting of about 45 acres of beech.

4. Prohibition of clear cuttings and substitution of annual thinnings in all stands of suitable age.

5. With the opening up of the older stands excellent reproduction came in and was preserved.

Points 1, 2, and 3 cannot be claimed as characteristic of "Dauer-

waldwirtschaft." Their effect in building up poor soils already has been proven and is used with other methods of treatment. Trebeljahr further asserts that had these same three measures been applied to the forest in question even under a clear cutting method the same growth would have resulted as actually did accrue in the period of 1884 to 1913.

Point 4 is the only special characteristic as yet revealed of the "Dauerwaldwirtschaft."

The essential feature of the method is the continuous cover afforded the soil. This can only be attained by securing dense stands of pine reproduction underneath the old timber. Trebeljahr proceeds to show that pine reproduction comes in on bare mineral soil (even of poor quality) and not where heavy duff or moss cover exists. The Dauerwald thus appears an impossibility for pine. But how then explain the abundant reproduction secured in the period 1884 to 1913 in the older pine stands of the Bärenthoren forest? Trebeljahr attributes this to the litter gathering which was the rule before 1884. The reason it did not follow immediately on the cessation of the litter gathering was lack of seed trees of the proper age and character. Another serious obstacle to its successful use is the difficulty and expense of harvesting the remainder of the old stand without seriously damaging the young pine understory. Only cuttings of the group selection type appear feasible. As yet the experiment has not reached the stage where this operation must be undertaken. Practical difficulties of personnel and control are likely to prevent successful use of the method in forests of large size.

Muller [3] shows that the principles underlying continuous forest cover are already used in the selection method and in modifications of the shelterwood method verging toward selection. He comments on the practical difficulties of conducting thinnings annually on the same area and suggests a 3 to 5 year interval. Damage to reproduction through removal of the old stand can be kept within reasonable limits, while the difficulties of yield regulation should not prove insurmountable.

Weber [4] takes the same view of annual cuttings over the whole area as does Muller.[3] Such cuttings are ideal but likely to be impractical for various reasons, such as low prices for forest products, big areas under one management and inadequately trained personnel. Probably a return every three years is possible on the average.

Cieslar [5, 6] contributes two excellent articles analyzing Möller's

original article and emphasizing many of the same points as Muller[3] and Trebeljahr.[2] He states there will be no serious difficulties experienced in harvesting the timber under the new method as similar difficulties are already being overcome in practice under other methods.

Oberdieck[7] from practical experience during a 15-year period on one Revier where he worked toward securing a "continuous forest" comments on "Dauerwaldwirtschaft."

He considers the loss to reproduction through the annual felling and removal of timber of much greater consequence than does Möller. His plan for securing pine reproduction consists in making a seed cutting removing four-fifths of the volume. The reason for doing this is found in the fact that pine reproduction starts better on heavily than on lightly cut areas. Having only one-fifth of the volume of the original stand to remove from above the reproduction less injury is caused. Oberdieck has experimented with thinnings at 3, 5, and 10 year intervals and now favors a 3 to 5 year interval. Ten-year intervals are too long to obtain the good crown development, which is fundamental to the largest production. Where reproduction follows the thinnings not less than a 3-year interval should be used on account of the pine weevil. Attention is called to the fact that such intensive management as Möller advises requires extra expenditures for personnel. Part or all of the increased yield secured will be needed to offset these additional charges.

A long article by Eberbach[8] strongly presents the advantages of the new management and shows its practicability. He answers some of Trebeljahr's[2] criticisms, in particular attributing the improvement of soil conditions and growth to the unevenaged form of forest developed by "Dauerwaldwirtschaft." In all cutting the aim should be to increase or maintain this unevenaged condition. He shows that the idea of the normal forest involving a rotation age and certain relations between age classes is not essential in forest management. The actual production which can be and is taken out continually is the test. German forest management grew up under the necessity of organizing rundown forest areas and of providing for a sustained yield of wood. Simple means for accomplishing this were needed. The normal forest was created as an ideal. Now times have changed and new methods and ideals are in order.

Möller[9] in February, 1921, replies to Trebeljahr[2] at considerable length answering his objections. He admits that from the practical standpoint the annual cuttings should be modified so as to require

a return to a given area only once in 3 to 5 years. As a means of regulating the cut he suggests measuring the growing stock at the beginning and end of each short period (5-year) and by comparing the two totals judge whether or not the annual cut has been fixed at a proper amount. Trebeljahr [10] makes prompt answer to this second article of Möller's asserting his original contentions and appears to have the best of the argument.

Buffe [11] comments interestingly on a trip he made to the forest at Bärenthoren. His conclusion is that while "Dauerwaldbetrieb" stands in contrast to clear-cutting it cannot be considered a new form of management. It produces the high forest form with natural regeneration and an exceptionally long reproduction period.

A selection form of stand is not likely to be produced by "Dauerwaldbetrieb"—at least not where the beginnings are made in evenaged stands.

He advises cuttings at intervals of 1 to 3 years depending on site quality, the shortest interval being on first quality sites.

The frequent thinnings have the effect of maintaining a rapid growth in the remaining larger trees, which spread out continually and constantly occupy nearly all the space. These larger trees all mature at approximately the same time and the area is finally turned over to young growth which though irregular in profile when released becomes more uniform with the passage of time.

Wagner [12] finds "Dauerwaldwirtschaft" admirable in its care of the soil and development of the stand but as yet lacking in a systematic arrangement for harvesting the crop without too great demands on the personnel.

Fabricius [13] [14] in a review of Wiebecke's [15] "Der Dauerwald" asserts that this is merely the selection system under a new name and with the advantages and disadvantages of the latter. This Wagner [16] denies. He considers the new and essential feature of "Dauerwaldwirtschaft" to be the continuous maintenance of soil fertility.

Basing his observations on field study of the results of "Dauerwaldbetrieb" at Bärenthoren H. Roth [17] sets forth very clearly the character of the treatment typical of the method.

He divides its procedure into four sections as follows:

1. At first the stand is kept closed with the purpose of developing long clear boles. Cutting of advance growth and removal of wolf trees, early thinning of thickets of young growth, leaving of tops and felled

trees on the ground to rot, and annual or triannual light thinnings are the chief operations in this period.

2. When clear boles of 40 to 50 feet and 50 to 60 years in age have been produced then the canopy is freely broken by the gradual removal of the poorer stems. Rapid growth begins and natural reproduction starts. Within 20 years reproduction is complete. A mixture of planted or naturally reproduced beech occupying not over 0.3 of the space is welcomed. The stand is now about 70 years of age. With young growth well established the old trees are gradually removed.

3. The greatest possible number of standards are retained in an upper story over the young growth. These are held so long as they maintain satisfactory growth. They may remain one or more rotations.

4. Finally the young growth shoots up until it enters the upper story. Opening up of this new upper story and the development of another under story of young growth completes the cycle.

"Dauerwaldwirtschaft" thus produces a 2-storied high forest. It is admitted that the 2-storied form might in theory be altered into one that approached selection, but as observed in practice this has not yet been done. Attention is called to the fact that most of the procedure characteristic of the method can and has been used in the application of other high forest methods. The avoidance of clear cuttings and the constant use of all details of treatment already described may be taken as the essence of "Dauerwaldwirtschaft" which justifies its being considered a separate method of treatment.

Reiss [18] shows that for the last 35 years new ideas and methods of management for Scotch pine have been conceived and strongly advocated but that clear cutting with artificial regeneration still holds sway in practice.

Wagner [19] contributes an excellent review of Möller's [20] book "Dauerwaldwirtschaft." The article comes after two years of discussion during which a variety of viewpoints have found expression and impresses the reader with the reasonableness of its conclusions.

Wagner insists that Möller does not propose "Dauerwaldbetrieb" as a new form of management entitled to find its place beside the many old systems; rather he divides all forms of management into (1) those employing clear cutting and (2) those maintaining a continuous forest. It is evident then that "Dauerwaldwirtschaft" may be practiced under several of the previously used methods of management.

"Dauerwaldwirtschaft" is the art of utilizing to the fullest extent the productive energy of the forest and places the emphasis on care and development of the stand rather than on its regeneration.

The example of the forest at Bärenthoren has not progressed far enough as yet to determine whether an unevenaged or a 2-storied high forest will be produced. The difference between the two hinges upon the length of the period within which, what is now (at Bärenthoren) the upper story, is utilized.

Wagner indicates that the benefits of a continuous forest may be obtained under either form.

Wagner's contribution makes a good stopping point in this review of the series of articles on "Dauerwaldwirtschaft." Doubtless more will be written, but a wide variety of opinion has already been expressed. On the whole the comment has been favorable to Möller's "Dauerwaldwirtschaft."

The effects of the war have brought out even more clearly than before the fact that the forest is one of Europe's chief natural resources and emphasizes in the minds of the foresters the need to bring the productive power of the forest areas to the maximum. Möller's plan of procedure, although most of the details are not new, fits in with the general spirit of the times and perhaps puts in concrete expression what had been in the minds of many men. The continuous forest idea should be of value with all species not alone with Scotch pine, but especially with those growing on the poorer sites with low rainfall.

What application can be made of the continuous forest idea to the forests of the United States?

It must be admitted first of all that maintenance of a continuous forest with constantly increasing productiveness demands intensive silviculture. Forestry in the United States has not yet reached the stage where intensive silviculture is in general practicable. Exceptions occur today in certain more favorably located areas where the application of intensive silviculture is beginning. Even here, however, it may well be questioned whether direct application can now be made of the program. Without doubt use can be made of various details of the procedure and the tendency of development should be toward maintenance of the continuous forest. A sentence from Cieslar's [6] article (freely translated) expresses the ideal: "A careful tending of the soil, a rational development of the stand, a continuous employment

of the energy of the sun and soil with use of natural regeneration, these are the pillars of a good silviculture."

Weber [4] states that in the 19th century too great importance was attached in German forestry to regulation by area. This was logical because the foresters early in the century had to deal with irregular, rundown stands with none too good markets and relatively ignorant personnel. Regulation by area furnished easy and simple control. Clear cutting fitted in with this method of regulation and with the forest and economic conditions of the times and was widely adopted. Regulation dominated silviculture to the detriment of the productive power of the site. With the 20th century came a recognition of the evils of clear cutting and regulation by area and a realization that silviculture should assume the primary place, with regulation relegated to a secondary position.

Today in starting the practice of forestry in the United States we labor under handicaps of forest conditions, personnel and economic conditions in broader aspects comparable with conditions abroad in the 19th century. We may have to pass through a stage where clear cuttings play a prominent part and regulation may seem to overshadow silviculture. Some even admit this (see article by S. T. Dana [21]). It may well be that the first step in changing from exploitation of timber to the practice of forestry is best accomplished by a strict regulation as to areas cut over or amounts cut in a given year, and that at first this seems the key point of the new régime. Once the idea of a steady return from the forest area is grasped and admitted then the emphasis can be shifted to where it belongs, namely, to the production of the crop.

In many places and under many circumstances the use of clear cutting may be now and for considerable periods demanded—indeed in some cases clear cutting may always be the best silviculture. Our climatic conditions, and ability of many species to reproduce well naturally on clearings may justify retention of clear cutting methods. However, it is well to profit by European experience to the extent of realizing that the tendency in silviculture is away from clear cutting and toward the continuous forest as a goal.

Intensive silviculture will come only so fast as allowed by economic conditions, upon which all application of silviculture depends.

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NOTES

Alfred Gaskill Retires From Active Public Service

With the resignation on July 1 of Alfred Gaskill as State Forester of New Jersey, a position which he has held since 1907, forestry sees the retirement from active service of one of its most able leaders. Taking up forestry in its early days in this country, he has done much to guide its thought and action to its present state of development. His mature, well balanced judgment, based upon years of experience in the business world, his many years of study both in this country and abroad, his wide knowledge of fundamental economic conditions, his fair-mindedness, his determination to stand firmly for what he knew to be right, his upstanding honesty and fine character have well fitted him for the position of leadership he has so well occupied. Those who have been associated with him during forestry's struggle for recognition love the man no less than they respect his judgment.

In 1898, Mr. Gaskill retired from the glass manufacturing business in southern New Jersey and entered the Biltmore School of Forestry. After a year's study he made extensive investigations for the Government Bureau of Forestry on the Pacific Coast. In 1899 he continued his studies at Harvard University and from 1900 to 1901 traveled through Europe, studying forestry conditions on the Continent, supplemented by forestry courses at the University of Munich. In 1902 he returned to this country and entered the U. S. Forest Service, where he gave five years of his time to forest fire, silvicultural, and editorial work. He resigned from the Forest Service in 1907 to become Secretary of the New Jersey Forestry Commission, and later, State Forester, which position he has held until his resignation in 1922. In 1915, when the several forestry, geology, water, park and other bureuas of the State were merged into the one Department of Conservation and Development, he was made Director of the Department, as well as State Forester, and has served as such until ill health, and a desire to give up active public work, influenced him to resign from both positions.

Starting with practically no organization in 1907, Mr. Gaskill builded wisely and well. Forestry in New Jersey is based upon a solid founda-

tion of constant, well balanced progress, cemented together by public approval and support. True, only a beginning has yet been made, but it is a good beginning, and it is doubtful if any other State can show more steady, healthful progress. It is based upon achievement rather than false promises, impossible to carry out, and for this position, Alfred Gaskill deserves unlimited credit.

Always conservative, Mr. Gaskill has continually shown his qualities of leadership in originating and standing steadfastly by sound policies. It must be gratifying to him to see many of these policies, at first regarded as revolutionary by many foresters, finally accepted as those upon which forestry must stand. He was one of the first foresters to take the definite stand that the practice of forestry was hopeless unless and until forest fires were controlled. For years he has stood firmly on the ground that fire control is the basis of all forestry. In the beginning he realized that without public support, forestry progresses slowly and is subject to setbacks. In New Jersey there has been no setbacks. Mr. Gaskill won public support. He has constantly worked to decentralize forest direction, believing that it is best to build an organization in each State based upon local conditions and opportunities. He has always led in clear thinking about lumber needs, forest taxation, and the relations of the public to forest owners.

As an early member of the Society of American Foresters, as one of the organizers of the Eastern Foresters' Association, and as director in the American Forestry Association, he has had ample opportunity to spread the influence of his policies and belief far beyond the limit of New Jersey forestry. His counsel has always been sought in meetings of foresters where National problems were to be considered.

As yet America has too few foresters with the experience and judgment necessary to solve many of the problems, national and local, that confront forestry. It is to be sincerely hoped that Mr. Gaskill's retirement from active public service will enable him to give even more time to broader fields of leadership for which no man is better fitted.

Monterey Pine in South Australia and New Zealand

Anyone who reads current forestry literature in regard to South Australia and New Zealand cannot help being impressed with the high regard in which Monterey pine is held in that region and the really

remarkable growth which the tree has made. It was first introduced into South Australia as a tree for plantations some 40 or 50 years ago. A recent number of "Te Karere O Tane," a monthly news letter issued by the personnel of the State Forest Service in New Zealand, gives some figures upon the growth of this tree. In a plantation 40 to 50 years old some specimens of Monterey pine had reached a height of 150 feet and a diameter of 4 feet at breast height. Douglas fir of the same age in the same plantation was the next largest tree in size, and it had reached a height of 100 feet and a diameter of 2 feet 6 inches.

Eucalypts in mixture with Monterey pine occurs in a number of plantations but invariably one or the other of these species suffered through suppression by the other. Eucalypts have been the chief sufferers, as in most cases Monterey pine has outstripped them in growth and the value of the latter is negligible. Speaking in general of introduced species it is said that the tree which stands out as being the best to withstand the exigencies of climate, disease, and so forth, is Monterey pine which seems to do equally well in almost any soil or aspect.

Some interesting figures on yield of plantations of this species are given in the Australian Forestry Journal of May 15, 1922. In Bundaleer, South Australia, with an annual rainfall of about 21 inches the stand per acre amounted to 6,000 cubic feet in 26 years, stem timber down to 4 inches in diameter being measured. At Mt. McIntyre, with a higher rainfall and cooler climate, a yield per acre of 8,400 cubic feet in 30 years has been recorded. Timber from the older plantations has been logged and found eminently suitable for a good many purposes.

The question naturally arises as to whether foresters in this country are not overlooking a species which might be very well adapted for growth in some portions of the country, such for instance as parts of the Southern States, even though there may not be opportunities for its extensive propagation in the California region to which it is native.

C. R. T.

Dr. Fernow's Recognition

In recognition of Dr. Fernow's distinguished achievements, the Trustees of Cornell University in June last authorized the naming of the Forestry Building at Cornell, Fernow Hall.

The basis for this action is Dr. Fernow's long and efficient service as the first head of the Division of Forestry of the U. S. Department of Agriculture, from 1886-1898; the fact that he organized and for

several years was Dean of the first school of forestry on this continent—the old New York State College of Forestry at Cornell University; the further contribution to forestry education that he made as Dean of the first forest school in Canada—that at the University of Toronto; together with the many and varied contributions to the cause of Forestry that he has made in other ways.

On Thursday afternoon, October 5, 1922, at 2:30 o'clock there was unveiled the tablet over the main entrance to the Forestry Building at Cornell that bore Dr. Fernow's name. A simple ceremony had been arranged to mark this event. It included brief addresses by the President of the University, Dr. Livingston Farrand, and by the Dean of the New York State College of Agriculture, Mr. Albert R. Mann.

Dr. Fernow's present address is 16 Admiral Road, Toronto, Canada.

Proposed Memorial Tablet to Dr. Joseph Trimble Rothrock

The friends of Dr. Rothrock are arranging to place a memorial tablet to his memory in the rooms of the Department of Forestry of Pennsylvania, in the Capitol Building at Harrisburg.

The State Commissioner of Forestry, Major R. Y. Stuart, has appointed the following Committee to take this matter in hand: Dr. Henry S. Drinker and Colonel Henry W. Shoemaker, members of the State Forest Commission; Mr. George H. Wirt, Chief Forest Fire Warden; Professor Joseph S. Illick, Chief, Office of Research; and Major Stuart, ex-officio.

It is hoped and expected that sufficiently large contributions to this fund will be received to enable the committee to procure a large bronze tablet containing a medallion portrait of Dr. Rothrock, executed with artistic taste, and including an inscription giving a succinct record of Dr. Rothrock's great and valuable services to the cause of forestry and to humanity.

Friends desiring to contribute will please mail check or postoffice order to Dr. Henry S. Drinker, Chairman, Merion Station, Montgomery County, Pa.

Nelson C. Brown Honored

On May 28, Nelson C. Brown was knighted by the Italian Government and made a Knight of the Crown of Italy. He is no longer an ordinary mortal, but a "Cavaliere di Corona d'Italia," if you please.

Botanical Abstracts

Attention of members of the Society is called to the announcement in this issue of reduced subscription price for Botanical Abstracts. This journal, which presents abstracts of practically all current articles on botanical and related subjects, including forestry, appearing in the United States and foreign countries, is published under the direction of a Board of Control, on which the Society of American Foresters has two representatives. To take advantage of the reduced rate, prompt action is necessary.

Reduced Prices for Reprints

Attention of members of the Society and others contributing articles to the Journal of Forestry is called to the reduction in the prices of reprints as announced by the printers of the Journal in their advertisement in this issue.

SOCIETY AFFAIRS

Annual Meeting.

The annual meeting of the Society will be held between December 26 and 30 at Boston, in connection with the meeting of the American Association for the Advancement of Science. It is planned also to cooperate with the Massachusetts Forestry Association, which will celebrate its twenty-fifth anniversary at the same time. Members of the Society who desire to present papers at the meeting are requested to submit their titles, with statements of the time that will be required for their presentation and a brief summary of their contents, to any member of the Committee on Arrangements—R. T. Fisher, Petersham, Mass.; H. H. Chapman, New Haven, Conn.; or W. N. Sparhawk, Washington, D. C. To be included in the final program these should be received before December 1.

Nominations for Officers

Attention of Senior Members is hereby called to the following provision of the Constitution of the Society:

"Other nominations, if indorsed by at least ten (10) Senior Members or Fellows and presented to the Secretary in writing at least four (4) weeks before the annual meeting, shall also be submitted to the membership on the official ballot."

As the ballots must be printed and submitted not less than four weeks before the annual meeting, it is desirable that nominations made under the above provision be in the hands of the Secretary at least six weeks before the meeting, which is to be held between December 26 and 30. Officers to be elected are the President, Vice-President, Secretary, Treasurer, and a member of the Executive Council for the five years 1923-1927.

Membership

The following members have been dropped from the Society, in accordance with Article X, Section 3 of the Constitution:

Senior Members: Bristow Adams, D. N. Mathews.

The following has declined to accept election:

Member: S. A. Boulden, elected March 23, 1922.

The following men, having neither accepted nor declined election, have been dropped from the rolls:

Senior Members: W. W. White and E. J. Yeomans, elected November 26, 1921.

Members: C. B. Arentson, elected January 12, 1921; R. T. Gheen, L. C. Hurtt, and P. H. Roberts, elected November 26, 1921; Frank P. Cunningham, R. H. Grabow, Thomas W. Sloane, W. H. Swanson, and Warren P. Upham, elected March 23, 1922.

Proposed Amendments to the Constitution of the Society

The California Section has submitted the following resolutions, which were adopted by the Section, proposing changes in the method of electing Members and Associate Members of the Society, and also in the composition and method of choosing the Executive Council. In order that these proposals may have full consideration, it is suggested that any member wishing to present arguments pro or con do so in writing within the next two weeks, in order that the statements may be used in the November issue of the Journal.

W. N. Sparhawk,
Secretary.

Resolution No. 1.

Whereas, Elections to membership in the Society of American Foresters require an unduly long period of time on account of the cumbersome procedure in effect, and,

Whereas, The decision as to the eligibility of candidates for the non-voting grades of member and associate member does not involve a difficult discrimination as to what constitutes an achievement, but is based on facts which can best be judged by those most closely acquainted with the candidates, and,

Whereas, To relieve the Executive Council of the duty of electing these two grades would undoubtedly permit more prompt and discriminating action on elections to the more important grades,

Therefore, be it Resolved, That the election of these two grades, member and associate member, should normally be placed in the hands of the Sections and that the accompanying amendment to the constitution therefore be forwarded to the Executive Council with the request that it be put before the Society by letter ballot, as provided by Article II of the Constitution.

PROPOSED AMENDMENT TO CONSTITUTION SOCIETY OF AMERICAN FORESTERS (NUMBER 1).

The Constitution shall be amended by substituting for Article 3, Section 2, the following:

Section 2-A. The election of senior members, honorary members and corresponding members shall be by the Executive Council, in accordance with the following procedure:

The names of candidates shall be submitted in writing to the Member of the Executive Council designated "In Charge of Admissions," accompanied by a biographical sketch, giving fully the qualifications of the candidate for admission to the designated grade of membership in the Society. The names of all candidates proposed shall be referred to all Senior Members and Fellows for comment or protest at least one month before final action is taken by the Executive Council. The Executive Council will then decide what candidates shall be elected, seven affirmative votes being necessary to admit any candidate to membership in the Society. When any candidate is not elected, the member of the Executive Council in Charge of Admissions shall notify the member of the Society by whom the candidate was proposed.

2-B. The election of members and associate members residing in any locality within the boundaries of any Section shall be, by this Section, elected in accordance with the following procedure:

Each Section shall select a Committee on Membership to which names of candidates may be submitted in writing, accompanied by a biographical sketch, giving fully their qualifications for admission to the designated grade. The names of all candidates proposed shall then be voted on by letter ballot sent to all voting members of the Section. Candidates receiving affirmative votes amounting to three-fourths of all the votes cast, shall be considered elected. The Executive Council shall be notified promptly of the results of any such ballot and shall announce such results to the Society at large.

The election of members and associate members residing in localities not within the boundaries of any Section shall be by the Executive Council as specified for senior members and honorary members.

RESOLUTION NO. 2.

Whereas, Under the existing provisions of the Constitution for the Executive Council, control of the Society tends to remain in the hands of the Washington Section, and,

Whereas, Although in the past this control has been exercised with discrimination and tact yet it is contrary to the principles of democratic organization and menaces future discord, has been illustrated by the recent experience of a similarly constituted professional society of engineers, and,

Whereas, The Sections of the Society have developed in recent years into organizations of ever-increasing importance and vitality and already cover the greatest part of the total membership of the Society.

Therefore, be it Resolved, That the Executive Council shall be reorganized in such a manner that each Section shall be equitably represented thereon and that

the accompanying amendment to the Constitution providing therefor be forwarded to the Executive Council with the request that it be put before the Society by letter ballot as provided by Article II of the Constitution.

PROPOSED AMENDMENT TO CONSTITUTION SOCIETY OF AMERICAN FORESTERS (NUMBER 2).

The Constitution shall be amended by substituting for Article 5, Section 1, the following:

SECTION 1.—The Executive Council shall consist of the President of the Society as Chairman, ex-officio, and of one representative of each Section. Each representative shall serve five years and the terms of office shall be so arranged that as nearly as possible the same number of elections to this position be held each year. Each Section shall elect its representative by letter ballot and notify the President of the result.

The President shall designate yearly from the members of the Executive Council the Chairman of the Committee on Meetings and a member to be In Charge of Admissions. The other members of standing committees and the Editorial Board shall be appointed by the President, as hereinafter provided, and shall serve for one year, or until their successors are appointed. And by substituting in Article 3, Section 2, the words "A three-quarter affirmative vote being necessary to admit" for "seven affirmative votes being necessary to admit."

COMMENTS ON PROPOSED AMENDMENTS

By R. C. Bryant:

Resolution 1.—I am strongly opposed to any scheme which proposes to take the matter of election of members to the Society of American Foresters out of the hands of the Executive Council.

The argument advanced by the California Section, with reference to undue delays in passing on membership, may have been justified at occasional periods in the past, but I do not consider that it is true today. The eligibility of candidates during the last year has been determined as promptly as the best interests of the Society warrant and it is doubtful if any just criticism can now be made of the system.

Placing the election of men to the grade of "Member" or "Associate Member" in the hands of the various Sections undoubtedly would lead, sooner or later, to a marked deviation from standard practice, and this would be unfortunate, since the "Member" grade will be the chief source of Senior Members in the future.

Resolution 2.—The California Section is misinformed, when it states that the "control of the Society tends to remain in the hands of the Washington Section." An examination of the membership of the Ex-

ecutive Council will disclose that only three of the members are located in Washington. This has proved a great convenience to the Society in the expeditious handling of its business affairs. During the two years I was president of the Society I saw no evidence of any attempt on the part of the Washington Section to "run" Society affairs. It seems most unwise that an arbitrary method of choosing the members of the Executive Council should be adopted to care for an imaginary evil.

By W. B. Greeley:

I cannot agree with the idea that the control of the Society of American Foresters has tended to remain in the hands of the Washington Section. The tendency has been in exactly the opposite direction, as an analysis of the personnel of the officers and members of the Executive Council during the last ten years will demonstrate.

I am, however, in favor of both of the proposed amendments. It has been our desire to see the Society grow to truly national proportions, both geographically and as representing the various interests and groups within the profession. I believe that this national growth will be stimulated by strengthening the position of the Sections and increasing their local responsibility. I am for doing both as a matter of Society policy.

Control of the election of Members and Associate Members can, in my judgment, very properly be vested in the respective Sections. The change in the make-up of the Executive Council will present some difficulties on account of the unwieldy size and scattered distribution of its membership geographically and the consequent difficulty in transacting business. The chief weakness of the Council at the present time is the difficulty in getting its members together at intervals of sufficient frequency to thoroughly discuss Society matters and really shape its policies. This weakness would aparently be increased by the proposed change. Nevertheless, I believe in the principle of equal representation of all Sections upon the Council. It is democratic and in keeping with the growth and spirit of the Society. I am inclined to favor the change notwithstanding the mechanical difficulties that will attend the increased size of the Council in doing business.

By Filibert Roth:

I fully agree with the California men, and hope that the amendments may be adopted.

By H. S. Graves:

I cannot concur in either of the two amendments as proposed. With reference to Amendment Number 1, uniformity of standards in elections is a prime requisite in a technical organization like the Society of American Foresters. Such uniformity can be obtained only by centralizing the elections. Defects that may exist in the present system should be corrected through the procedure, not by decentralizing the elections.

I have sympathy with a desire for a wide representation on the Council. I question, however, the wisdom of having such a large body as would result from the proposed amendment. I am definitely opposed to having the Council composed of delegates. The officers should be elected by the Society, not by a part of the Society. If any change is made, it should, I believe, be in the direction of a regional representation, without increasing the present size of the Council.

By J. W. Toumey:

Personally I seriously doubt the wisdom of a change in the constitution of the Society along the lines proposed in either of the resolutions. I do not believe it is a hardship for some months to transpire after a man is proposed for election to the Society before he is elected. A matter of several months, as it is now, is, in my judgment, a good thing. If a man is acceptable for election to the Society a wait of a few months can be of but little esesntial difference to him. Personally, I would not change the present method and have one method for electing Members and another for electing Senior Members.

In my judgment, the second resolution deserves even more opposition than the first. An Executive Council composed of men, one elected from each Section with no limit to the number of Sections that may be organized in the future, is not, in my judgment, a suitable means for getting an effective working Executive Council. The Executive Council should be made up of men willing to do the work imposed upon them, with the majority near enough so the correspondence is not over-long delayed making possible important action by the Council slow.

By Gifford Pinchot:

Offhand, I should have some doubt as to the desirability of having

the election of members solely to each Section. Would it be possible to give a power of veto to the central body? I am not sure, but that is the way the thing strikes me at first sight.

By H. H. Chapman:

Comments on proposed amendments to Article 3, Section 2B:

The principal argument advanced in favor of this change is to shorten the period required to elect members. The cure offered is to localize the authority and procedure, at the same time substituting popular ballot for action by a committee. The proposal is defective in two respects. To be properly administered it would require the transmission of full evidence to each member of a Section, which would involve considerable expense and delay. Unless this is done, members will vote either on the basis of personal acquaintance or hearsay. The second objection lies in the tendency of Sections to depart from the standards of the Society in the election of members. The written constitution is supposed to serve as a standard, but the interpretation of the limitations on membership, even for these grades, if they are to be maintained as a uniform standard, is best left in the hands of a central council.

As a matter of fact, the endorsement as to character by a Section practically insures the election of any class of member except where he is not qualified for the grade proposed on account of the constitutional standards and their reasonable interpretation by duly elected members of the Council representing the entire Society, who are actuated not by local conditions and expediency but solely by a desire to uphold those standards. There have been several cases where candidates have failed of election on these grounds after receiving the endorsement of the Section. This check would disappear under the proposed amendments.

While the delay is often a matter of embarrassment to the candidate and his sponsors and in some cases has even caused disaffection and indifference to election, yet surely the chief objective of an election is not haste, but caution. Under any procedure, the names of candidates should be submitted for the comment of members, and if this is not to be a bi-weekly performance, it involves the delay incident to bunching the names, and then assembling the evidence, which is at best usually very meager. Had haste been the watchword, I am inclined to believe that in a few instances men would have been elected who where undesirable and failed of election.

The amendment seems defective also in requiring only a three-fourths vote of those cast, for election. Considering the tendency of the average member to vote yes unless absolutely convinced against a candidate, this margin seems too small to prevent the election of undesirable candidates.

The preparation of the list of candidates first for submission to members and later to the Council must probably remain the duty of some member of the Council who receives no salary and does this work entirely out of office hours as a gratuity. Since the reduction of delay seems very desirable, the Society should direct that a certain sum be set aside for clerk hire for the assistance of this member in charge of admissions. Lists could then be prepared at quarterly intervals on fixed dates. One month later copies of the evidence or biographies and comments could be sent simultaneously to all members of the Council. This procedure could have the additional merit of securing the vote of each elector entirely uninfluenced by the record of preceding votes. It is reasonable to suppose that the membership fees received would meet this increased outlay as well as pay for the subscription to the JOURNAL.

Knowing these dates, the Sections could act accordingly in their submission of names, and the candidate could be informed as to the probable time required for action on his case. This reform in office procedure seems preferable to decentralization of elections for any class of members.

The argument for amending Article 5, Section 1, is to insure a widely distributed representation on the Executive Council, which is very desirable. But it is doubtful whether the best interests of the Society would be served by confining the selection of the Council to one each from the existing Sections. The premise on which the amendment is based, namely, that the Washington Section controls the Society, is so far from the fact that other and better reasons must be sought or the contention breaks down. Until the Sections were formed, Washington was a nucleus which alone made possible the continued existence of the organization. At present, the Washington Section cuts an almost negligible figure in the affairs of the Society, compared with the influence wielded by the other Sections, both east and west. The fact that the Secretary, Treasurer, and Editor are usually chosen from members residing at Washington has nothing to do with the Section existing at that point, but is dictated by the most

fundamental necessities of executive organization. These officers are not chosen by this Section.

For many years it was the cry that the Forest Service controlled the Society and outside membership had an insufficient voice. The Sections, especially those in the East, have dispelled this idea. But as the existence of a Section is geographic, and as a majority of the Sections exist at points where in turn a majority of the members are also members of the Forest Service, the numerically strong eastern Sections might find, by this proposed amendment, that a large majority of the Board were also members of the Forest Service, through election by numerically weak Sections. I do not say that this would occur, nor submit it as an argument against the amendment, but it is at least as valid as an objection, as the argument cited in favor of the amendment.

If the Pacific Coast and Rocky Mountain Sections feel that they are not getting sectional representation, this might be secured by a simpler plan. The principle could be incorporated into the Constitution that representation on the Executive Council should be based as far as possible on the proportion of voting members residing respectively east and west of a certain meridian, thus throwing the Rocky Mountain and Pacific Coast into a group. The nominating committee could be instructed to select candidates in such a manner that the choice must fall, when required, on members living west of this meridian. This arrangement would be fair to the Society as a whole, and would leave the control of the Society where it belongs, namely, with the entire membership instead of with local Sections.

By S. T. Dana:

I am strongly opposed to both amendments to the Constitution suggested by the California Section. While delays in the election of new members have perhaps been unnecessarily long, and in some cases embarrassing to the candidates or their endorsers, I am afraid that the proposed cure would be worse than the disease. I cannot see that there is any great haste in the election of members, and some of the members of the Council have favored acting on candidates only once a year.

It seems to me that to allow each Section to elect Members and Associate Members would do away with any uniformity of standards and would gradually reduce the Society to a loosely knit organization of Sections varying widely in the character of their membership.

I cannot feel but that such a move would tend to disrupt the Society, and would certainly cause it to lose standing as a national organization of professional men.

A rather extended experience as the member of the Executive Council in charge of admissions has given me a very strong impression that standards of the different Sections do vary materially even now, and this tendency would undoubtedly become more pronounced if the Sections had authority to take final action. The Executive Council has acted, and I believe always must act, as the agency to bring about a reasonable uniformity in the standards of admission. The mere fact that the Council has declined to elect individuals proposed by various Sections is evident that it is functioning in this way. I also favor the continuation of the present practice of publishing lists of candidates for comments by the membership generally. Such publication has not infrequently resulted in the securing by the Executive Council of important information regarding the candidate's fitness for election, which would not otherwise come to its attention.

I also disapprove of the second amendment proposed by the California Section, the disadvantages of which seem to me to far outweigh the advantages. We cannot have a Society that is really national in scope, unless its officers are chosen from and are representative of the entire Society. The danger that the Society may be dominated by the Washington Section is certainly not sufficiently serious to necessitate so radical a change as that suggested by the proposed amendment. The present Constitution provides for the nominating of officers by petition, in addition to the nominations made by the nominating committee, and thus allows the Sections to present the names of any men especially qualified for election to the Council.

By F. W. Besley:

It seems to me that the Society has, in the past two or three years, gone pretty carefully into the matter of electing members and that the procedure adopted should not be changed, unless upon further trial it is found to be cumbersome and impractical. I am opposed to the election of Members and Associate Members by the Sections, as this is likely to lead to an indiscriminate inclusion of unqualified members. The present method of submitting names to the Executive Council should not require an unreasonable amount of time before action can be expected upon any candidate that may be proposed.

Denver Section

The Denver Section has elected the following officers for the year, May 1, 1922, to April 30, 1923:

Chairman, M. W. Thompson.
Vice-Chairman, J. H. Hatton.
Secretary-Treasurer, Wallace J. Pearce, Forest Service, Denver, Colo.

New England Section

The New England Section held its summer meeting on July 15 and 16 at the Mt. Wachusett State Reservation in Princeton, Massachusetts, and the members were housed in the hotel on the mountain summit. Some 35 members and guests were present. As is customary at our summer meetings, the time was devoted largely to sightseeing in the field. An interesting inspection was made of the 1,600 acres of pine and spruce plantations belonging to the Metropolitan Water Commission around the Wachusett Reservoir which supplies Greater Boston with water. Some of these plantations were made over 20 years ago, so that reforested land in all stages from 2 to 20 years was on view. An afternoon was spent in the chair factory of the Heywood Brothers & Wakefield Co. at Gardner, Massachusetts, nearby, the largest plant of its kind in the world.

There was routine business transacted, including the endorsement of eight men for membership in the Society. Among other things the Section passed a resolution opposing the proposal of the Pacific Coast Section that members be elected directly by the Sections and second that the Executive Council be composed of representatives of the Sections.

Summer Meeting of Southern Appalachian Section

This Section, which was the first to be organized in the South, held its second meeting in Asheville, N. C., on June 23, the day following the adjournment of the Southern Appalachian Water Power Conference. Mayor Gallatin Roberts of Asheville, who is President of the North Carolina Forestry Association, opened with a brief introductory talk, which was followed by a symposium on the subject of forests in relation to stream-flow and erosion, and forest fires, as follows:

"Forests and Stream Control," by Col. Joseph Hyde Pratt, Director North Carolina Geological and Economic Survey.

"Soil Erosion in Relation to Utilization of Streams," by W. W. Ashe, U. S. Forest Service, Washington, D. C.

"Lessons from the Rock Creek and Locust Ridge Fires," by E. F. McCarthy and R. T. Reed, U. S. Forest Service.

The following resolution was unanimously passed by the meeting:

"In view of the need expressed on June 22 by the Southern Appalachian Water Power Conference in session at Asheville, N. C., that further studies be made in the relation of forests to streamflow, and in consequence of the feeling among foresters that more definite data on this subject for the various regions of the country is most desirable, we hereby urge that the proper Federal and State agencies undertake as soon as possible investigations leading to this end."

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